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Design and Operation of the United Comstock Mill—I

How problems of construction, crushing, grinding and concentration were solved

By B. P. Little

Formerly Chief Engineer, United Comstock Mines Co.

The First Use of Metals—Gold and Silver

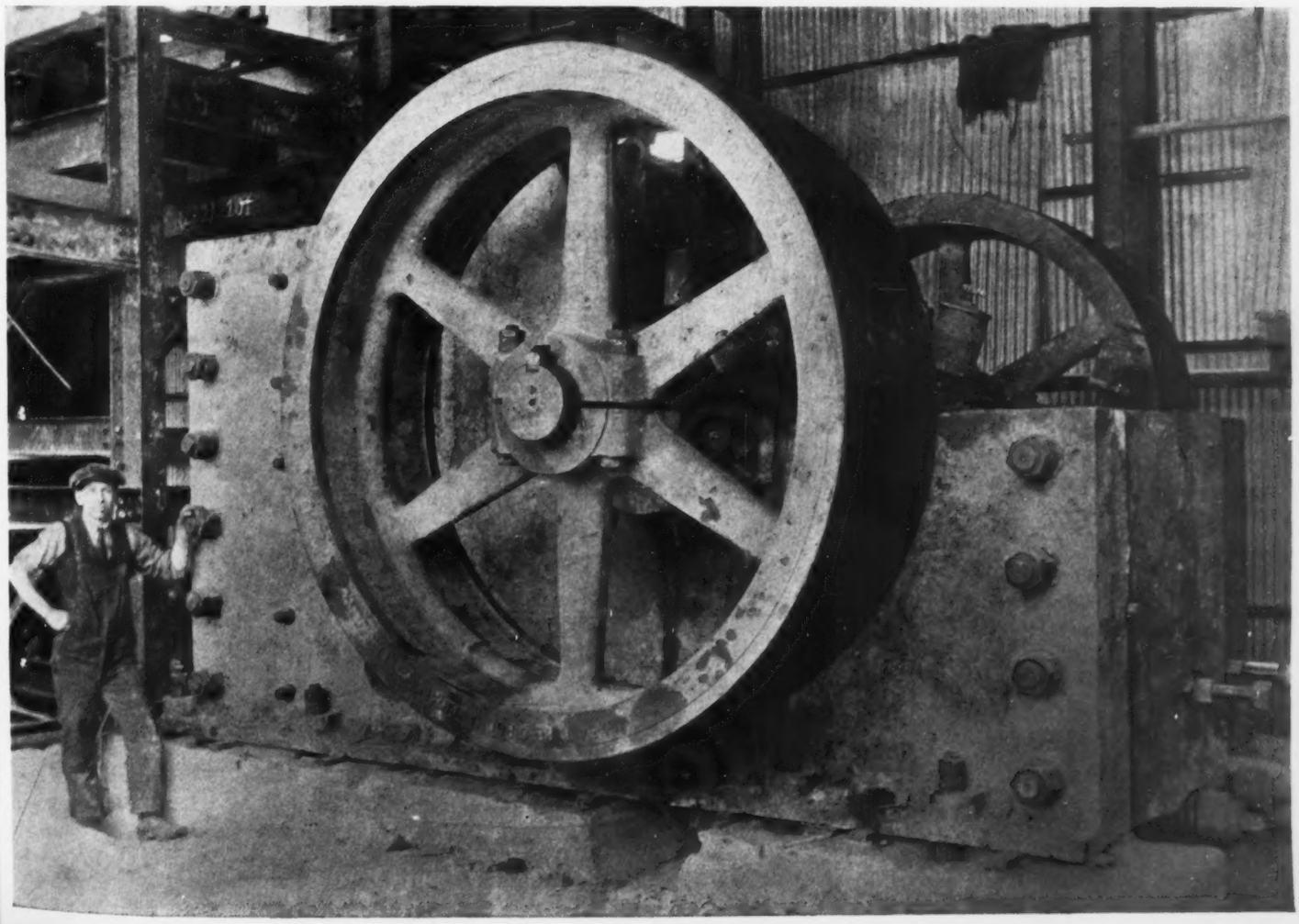
By T. A. Rickard

Recording Churn Drill Data

By James E. Harding

American Equipment at a British Quarry

Jaw crusher, capacity 200 tons per hour to 5 in. size, weight 180,000 lb., recently installed by Constable, Hart & Co., Ltd., in Derbyshire



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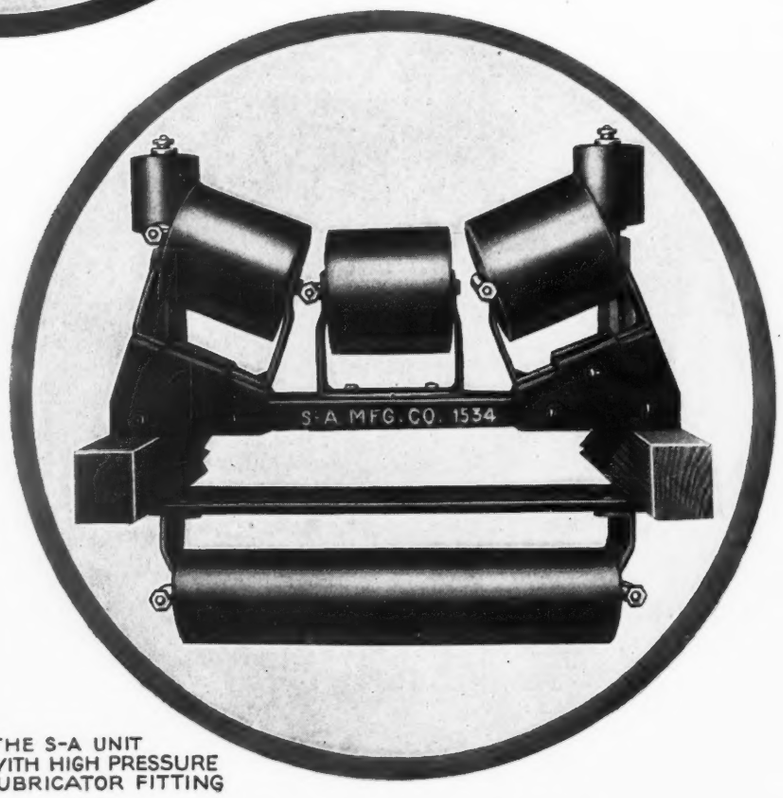

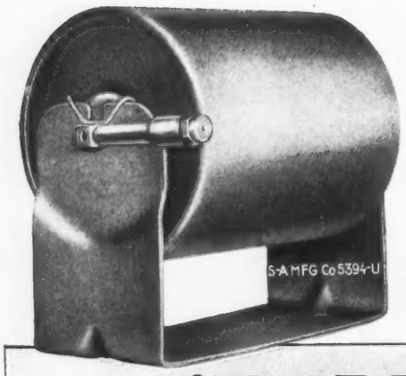

THE S-A UNIT WITH HIGH PRESSURE LUBRICATOR FITTING

STEPHENS-ADAMSON

AURORA **MFG. CO.** ILLINOIS

ENGINEERING & MINING
JOURNAL-PRESS
JOSIAH EDWARD SPURR, Editor

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The Metal Markets and the Franc

LAST WEEK all of the non-ferrous metals declined in price sharply and simultaneously. Ordinarily a movement of the markets upward or downward occasions little comment—it is accepted as part of the game—but this time certain economic agencies or forces of peculiar origin and effect were at work, and they are worth particular mention. Strange as it may seem, the decline in the metal markets in the United States was attributable to forces behind the sharp advance in the value of the franc. The two actions were related in the following manner: European speculators in francs had been selling the franc "short" for many weeks and had shown a large paper profit doing so. Some of their operations extended to the metal markets —that is, they bought non-ferrous metals in France for future delivery—as far ahead as possible—expecting to pay for them with depreciated francs when the time of delivery arrived. Other speculators dealt directly in francs and metals separately. When unexpected support for the franc appeared in the form of a $100,000,000 loan from American bankers, the franc reversed its direction and began advancing rapidly in value. Speculators who had played for a decline were caught badly. In order to limit their losses or settle for them completely they either sold the metal they had bought previously or sold an equivalent tonnage in London, the most open market in the world, where any metal can be bought and sold freely in small or large amounts. This sudden rush of orders to sell naturally depressed metal prices in London. Tin dropped £20 overnight, copper and lead £1¼ in one day. The New York market quickly felt this reaction, and prices began to sag here. None of the non-ferrous metals escaped. Even lead, the Samson of the metals, showed weakness. The entire chain of events is an interesting example of how the metal markets became innocent victims of the attempt to check the fall of the franc. The franc rose and copper, lead, zinc, and tin declined.

Those American copper miners who have not grasped the international relation of the metal markets have here an excellent example of how closely knit together and sensitive they are, not only to conditions in their own field, but also to conditions in others.

Manganese in the United States

MANGANESE was one of the famous War Minerals during the World War: meaning that it was one of the essential metals of which we were not producing sufficient for our own needs. Hence, during the war the government sought to stimulate the production of domestic manganese, and with surprising success. Yet the close of the war showed that nearly all this manganese had been produced at a loss, which loss Congress decided to make good from a special appropriation called the War Minerals Relief fund. Altogether 410 concerns and individuals produced manganese during the war; and 461 claims for loss were filed with the War Minerals Relief Commission. But the newly embarked manganese producers, even with the prospect of reimbursement of past losses in sight, viewed with concern the flat peaceful years ahead, when the country would revert to its pre-war practice of buying all its manganese from overseas—chiefly from India, Russia, and Brazil. Hence, a strong group, working on Congress, with the aid of the American Mining Congress organization, procured a tariff on manganese of one cent per pound of metallic manganese, it being contended that there were vast reserves of manganese, and that this tariff would allow the infant industry to grow; so that not only would the domestic producers find the enterprise profitable but they would be ready, in case of a future national emergency, to supply manganese in sufficient quantity.

The work of the Mining and Metallurgical Society of America, through its special committee on Foreign and Domestic Mining Policy, and its subcommittees, has borne fruit in unbiased reports on the domestic reserves and industrial situation of many of the most-debated minerals and metals. We have referred to some of these previously. Now we have the report of the subcommittee on manganese, of which Mr. C. M. Weld is chairman. Other members are D. F. Hewett, J. W. Furness, J. V. W. Reynders, John A. Mathews, Bradley Stoughton, and Robert Linton. A somewhat similar report has been made to the American Institute of Mining and Metallurgical Engineers, by the same group, functioning as a subcommittee of the Committee on Industrial Preparedness.

The report of the Manganese subcommittee shows every mark of thorough and painstaking consideration: it is also clearly written. It is manifestly a difficult thing to estimate national ore reserves: especially in the case of manganese, on account of the irregular habit of most manganese ore deposits. Nevertheless, the committee has done this to the best of its ability; and it is safe to say that it could not be done better, and that we may accept its approximation as a basis for conclusions. The price of 50 per cent manganese ore in 1922 was $15 per ton: at present it is around $22-$23 per ton. The former figure corresponds to an index number for manganese (compared with average prices based on a parity at 1913) of $10. The committee supposes, for the sake of argument, that the price of manganese would sky-rocket—due to the disappearance, for any reason, of the foreign competition (a most unlikely condition)—to five times this figure, or a price index figure of $50 per ton, on ferro-grade ores (suitable for the manufacture of ferromanganese and containing over 35 per cent of manganese). Under these conditions the United States might produce, the first year of such stimulation, 46,000 tons of recoverable manganese metal, 82,000 the second year, and 105,000 the third. Thereafter it is likely that the production would decline rather than increase, on account of progressive exhaustion of supplies. But at an index price

of $20 per ton, only 10,200 tons of manganese metal would be produced the third year, and at a $35 index price, 61,100 tons. Now, the consumption of manganese metals from ferro-grade ores was, in 1922, 202,000 tons, about the same as that of the last pre-war year, 1913, which was nearly 197,000 tons.

Lower-grade ores (containing from 5 to 35 per cent manganese), which go into the manufacture of spiegeleisen, make up 15 per cent or less (in 1925 about 6 per cent) of the total manganese consumption. It is estimated that at least 70 per cent of the manganese consumed must be in ferromanganese form, which requires the higher-grade manganese ores. Therefore, even with the very high stimulating price ($50) which the committee supposes, and with foreign competition cut off, domestic sources would supply the first year of such stimulation only 23 per cent of the ferro needs; the second year, 41 per cent; the third year, 52 per cent; and from that time on, the output would be expected to decline.

It is altogether likely that the committee has been liberal in its figures of manganese reserves; but even with its liberality it is conclusively shown that our industrial policy leans on a broken reed if it contemplates future adequate sources from home. Moreover, it shows the vain hope of developing a growing manganese mining industry within our own borders. It is the proverbial endeavor to get blood out of a turnip.

As to the tariff now in effect, the committee reports that relatively no production of true ferro-grade manganese has resulted from it. A little chemical ore has been produced from one district in Montana and moderate amounts of lower-grade ores from Arkansas and Colorado. From the standpoint of national economy the committee believes that "Artificial stimuli in times of peace, which, if effective, will simply tend to deplete an already extremely limited reserve of ferro-grade and chemical ore, should be strongly discouraged."

Doodle Bugs and Electrical Prospecting

KEEPING A FOOL and his money from being parted often seems a hopeless task. "Where can I buy Jacob's improved oil and water rod," writes someone from a southern state. "Don't" is our reply. An explanation seems superfluous. The blunt statement that such devices are worthless is probably more effective than elaborate reasons why. The temptation is strong, however, to add that, though the doodle bug is a fake, there are scientific methods of prospecting with electrical equipment that promise to be valuable aids to the geologist in locating ore deposits. But such a distinction would mean nothing to the ignorant.

One of the interesting papers at the Canadian Institute meeting gives the results of the most recent electrical prospecting in Canada. In it, Sherwin F. Kelly briefly describes Schlumberger's two methods of prospecting, the first, by studying the distribution of a direct current (not an alternating current as accidentally stated editorially last week) which is passed through the ground between two points a convenient distance apart; and the second, by studying the currents spontaneously produced in the orebodies themselves. The more recent work of both Schlumberger and Kelly has been done chiefly with this second method, which is more convenient than the first, though of more limited application.

In concluding, Mr. Kelly says: "This new tool is by no means a cure-all for the difficulties that beset the prospecting geologist. It is not a doodle bug to be carried about in unpromising territory in a haphazard manner. Neither is it a mystic affair that will at once tell the operator what kind of ore he has and how much it is worth. On the contrary, it is but another tool to be used for the solution of geological problems."

It is unfortunately true that the success that these scientists may have in their research experiments will probably be straightway capitalized by the fakers in preying on the ignorant with their doodle bugs. But experience alone can protect the ignorant.

Idaho Gold Corporation, George Graham Rice, Samuel Newhouse, Sidney Norman, Et Al.

IN OUR ISSUE of Jan. 5 we published a dispatch from Boise, Idaho, regarding the Idaho Gold Corporation, which some time ago "took over" sundry old prospects in Idaho. It said:

"Stewart Campbell, State Mine Inspector for Idaho, after a personal inspection of the property of the Idaho Gold Corporation at Rocky Bar, Idaho, has issued a public warning to prospective purchasers of shares of that company. He states that samples taken by him from the vein which recent press articles declared assayed $475 per ton in gold, did not assay to exceed $36; that the vein does not have the appearance, in his opinion, of promising the development of a mine. He says that the company, of which Samuel Newhouse was recently elected president and manager, has never complied with the blue-sky laws of Idaho, and that its advertising circulars and press articles are misleading."

In reply to a telegram from us, C. C. Moore, Governor of Idaho, confirmed the report and added that Mr. Campbell had been unable to serve formal action against the Idaho Gold Corporation, as the statutory agent of the corporation had resigned. It seems that this official, one Jess Hawley, Boise attorney, wired his resignation to New York to take effect immediately, on the day that Mr. Campbell made public the statement on which the above dispatch was based.

On Dec. 28 Samuel Newhouse wired Stewart Campbell from Salt Lake City asking him "to withhold drastic action until the opportunity had been afforded to file the report," on the plea that being newly elected as an official of the company he had not been aware of the delinquency. In this telegram he said, "If I had any doubts about the merits of the property, or if there was anything I did not wish to have disclosed, I would surely not have wired you December fourteenth a cordial invitation to visit the property and make any statement which you might deem proper and just with reference to the mine." It was on this invitation, we understand, that Mr. Campbell did visit the mine in company with one Smith, an engineer, who obtained a number of samples at the mine.

Samuel Newhouse notified the Idaho State Mine Inspector by telegraph on Jan. 3 that he had resigned as president and director of the Idaho Gold Corporation, a fact which we published in our issue of Jan. 12.

On March 1 we published the news that George Graham Rice, notorious mine promoter of New York, had been chosen president of the Idaho Gold Corporation, the dispatch from Idaho saying that "Rice succeeds Samuel Newhouse, of Salt Lake, who recently resigned as president of the company when Mr. Camp-

bell issued a statement that the publicity literature of the company was misleading."

The inference, we confess, is that the literature in question was issued without the knowledge of Mr. Newhouse; and that, when it was brought to his attention, he immediately severed his connection with the company. Apparently, this was not the case. What purport to be the real facts have been brought to our attention by none other than Rice himself, who, with John Hogan, of "Facts and Fakes of Wall Street," started a campaign to sell Idaho Gold stock as long ago as last July. Rice sends us a copy of the circular dated New York, Dec. 20, 1923, from which we quote:

"Salt Lake City, Utah, Dec. 18, 1923

"Mr. Julius Levy,
"Secretary Idaho Gold Corporation,
"New York City.

"It affords me real pleasure to officially advise you, for the information of the stockholders of the Idaho Gold Corporation, that when in Chicago enroute to Salt Lake I received information by wire of a new strike of 10 inches of ore sprinkled with gold.

"I immediately wired Mr. George H. Short, our consulting engineer in charge of the property, instructions to send samples to Salt Lake for assay, and simultaneously wired Mr. Harry S. Joseph, a prominent mining engineer in Salt Lake, asking him to go immediately to the property, make an examination, check up on the strike, and take his own samples for assay.

"Shortly after my arrival in Salt Lake I received the report of the assay of the samples sent down by Mr. Short which assay reads as follows:

" 'Clifton Bell vein, 10 inch high grade, gold $581; 12 inch sulphide, gold $17'.

"Mr. Joseph has just returned from his examination of the property and handed me the assay of an average sample which he took on the property showing $472 per ton gold ore, with this notation on the assay report, viz:

"The assay above is from a sampling of a streak of quartz in the Clifton Bell vein, the property of the Idaho Gold Corporation at Rocky Bar, Elmore County, Idaho. The sample taken was along the strike of the vein for a distance of 20 feet long and an average width of over 18 inches. I was most careful to take what I considered to be a most conservative sample, and, if anything, gave the mine the worst of it. HARRY S. JOSEPH."

"I feel that the stockholders are to be congratulated upon the splendid showing that the mine is making, particularly in this development stage. I feel that it is surely destined to be a great producer. SAMUEL NEWHOUSE."

Julius Levy is a lawyer of New York. G. H. Short calls himself an engineer, lives in Salt Lake City, and has, we understand, resigned his position with the Idaho Gold Corporation. H. S. Joseph is a "mining man" of Salt Lake City; he was prominently identified with the Bingham-Galena fiasco in Utah in 1921. Manifestly, Mr. Newhouse intended this telegram for the purpose for which it was used, so that the shocking of his sensibilities when he saw the circular could not well have caused his resignation. Rice declares that Mr. Newhouse resigned "as a result of the situation created by the attack of Mr. Campbell"; and that the resignation came only when the controlling interest in the company [Rice himself] telegraphed him a demand to resign.

Still another angle to this queer business: Rice writes us, "The engineer who did the sampling for Mr. Campbell was retained by Mr. Sidney Norman, editor of *Mining Truth*, Spokane, Washington, on my telegraphic request to send a competent man to the mine to check the engineer [Joseph] whom Mr. Newhouse had quoted, and I paid the bill. It may surprise Mr. Campbell to learn that I am responsible for sending the engineer to the mine in company with Mr. Campbell." Rice calls attention to the fact that since the company had never applied for permission to sell stock in Idaho Mr. Campbell had no legal right to make an examination, but that he [Rice] had wired Mr. Newhouse instructions to extend a formal invitation. This jibes with Newhouse's statement.

Rice apparently is the master mind; he presses the buttons and the others jump. He and his wife control an overwhelming majority of the 5,000,000 outstanding shares and his word is law. He wants a figurehead as president, and Newhouse swallows the bait. He demands good reports and Short and Joseph supply them, with the stamp of Newhouse's approval. His circular is branded as misrepresenting facts, and Newhouse becomes the goat. He wires Norman (to whom Rice in another letter to us refers as "my agent") to get an assayer, but to conceal the identity of the principal; Norman not only gets the assayer, but arranges in some way that he shall journey to the mine with the State Mine Inspector. Campbell accepts Rice's invitation, extended through Newhouse, to make the trip, and in exact accordance with Rice's plan journeys in company with the engineer engaged by Norman. Probably the plan was to disarm Mr. Campbell by being frank and open about the property and cordial to the inspector. Fortunately, Mr. Campbell is not so easily influenced, even though he may not be discriminating in the selection of the engineers with whom he travels. The mine at Rocky Bar has produced gold; it may produce more, but the project to date bears every sign that investors should treat it with formality rather than with fervor.

The Perspective of a Mining Engineer

THERE IS NO NEED to stress the inadvisability of entangling alliances abroad, but it must be admitted that travel and residence in foreign countries broadens the viewpoint and adds to the appreciation of home. Although we are reminded frequently that provincialism is a characteristic of so many utterances at Washington, we are thankful that at least one member of the Cabinet has not only traveled widely, but has lived abroad for a sufficient length of time to appreciate the advantage of a world outlook on matters of domestic policy. Mr. Hoover is still an engineer, applying fundamental engineering principles to the solution of problems that demand an appreciative and first-hand knowledge of foreign conditions.

Mr. Hoover's success prompts a query as to how much latent talent is concentrated among mining engineers as a group—talent that has crystallized in consequence of a world education. After the perusal of the personal column in a recent monthly bulletin of a mining and metallurgical society we made mental notes of the "spheres of influence" of some of its members in the brief space of thirty days or so. The countries mentioned as the destination or point of departure included Afghanistan, the Belgian Congo, Borneo, India, Burma, Canada, Ceylon, Cyprus, the Federated Malay States, the Gold Coast Colony, Mexico, Newfoundland, Nigeria, Peru, Rhodesia, Rumania, Spain, Turkey, and West Africa. The unrecorded peregrinations of other mining engineers in the same period of time would, if known, probably serve to quadruple the list.

The profession should be recognized, outside its special work, as an asset of national value. A few more Hoovers might well be translated into the seats of the mighty.

Design and Operation of the United Comstock Mill—I

How Problems of Construction, Crushing, Grinding, and Concentration Were Solved

By B. P. Little
Formerly Chief Engineer, United Comstock Mines Co.

THE ACTUAL PLANNING of the milling plant of the United Comstock Mines Co.[1] was started Nov. 1, 1921, under the direction of E. A. Strong, metallurgical engineer, who engaged me as chief draftsman. In the following June, Walter L. Reid, then consulting mill engineer of the Metals Exploration Co., assumed charge of the work and appointed me as chief engineer, in charge of design, and engaged A. J. Weinig as metallurgist, to sample and test the ores and work out the treatment plan and flow sheet. Although I was intimately in touch with the operation of the plant during its first year, my duties were restricted to mechanical design and installation and did not concern mill operation and management.

THE United Comstock mill aroused a good deal of comment when it was built two years ago, on account of certain unusual features. These included washing the ore, operating the ball mills in closed circuit with tables instead of classifiers, and a novel use of hydraulic classifiers and settling cones. In this intensely practical article, Mr. Little tells why much of the equipment was chosen, how it was installed, and the results that have been obtained in service. In the succeeding installment, to be published next week, the cyanide treatment will be covered, including sand leaching and the use of Moore filters.

Our initial instructions were to design a 1,000-ton cyanide plant for the treatment of 7-oz. silver ore, amortization to be assumed to extend over eight years. From the ore tests and other information available at that time, E. A. Strong had decided upon an all-sliming counter-current decantation treatment, without preliminary washing of the ore. Three layouts were developed sufficiently for detailed estimates of construction and operating costs to be made. The choice of building material and type of construction most economical for the local conditions were studied and comparative estimates were made for superstructures of wooden construction, reinforced concrete, and structural steel. The first cost was in the order named, the comparative figures in one instance being, for frame and wall covering: wood, 100; concrete, 144; steel, 175. Another example was the front wall of the fine-grinding building, shown in the table opposite.

The different types of framing, walling, and roofing practicable from the standpoint of cost were described in a memorandum submitted to the Board of Fire Underwriters and the insurance rate on each was obtained. The lowest rate on wooden frame construction, after installing all the protective devices for which the underwriters would allow credits, was $1.62 per $100, provided insurance to the extent of 80 per cent of full value was written. This would have amounted to $30,000 per year for 80 per cent insurance. The remaining 20 per cent of the risk assumed by the owners was estimated as $6,000 additional.

We found that the cost of all the mill buildings involving fire risk would range between 38 and 48 per cent of the total cost of the plant, depending upon the class of material employed for superstructures, and that by careful selection of various non-combustible materials the fire risk could be minimized to a point where insurance would be unnecessary by an additional expenditure of an amount equivalent to less than three years' premium. Drawings and estimates were made on this premise and checked against wood construction, and then, being sure of our ground, we were able to recommend non-combustible construction for the main plant buildings, with the necessary data to secure its approval.

Reinforced concrete showed a decided economy over steel and was therefore used wherever suitable, the particular exception being the tank house, where the height of the columns prevented the use of concrete in the superstructure. The only wood used was for roof sheathing (2-in. t. & g. Oregon pine) and in the tankage in the cyanide department. The laboratory and refinery buildings were sheathed with 2-in. concrete poured on HyRib and plastered underneath. Reinforced concrete construction was also more advantageous than steel, as its use avoided the sixty to ninety days required for the delivery of the steel, and this speeded up construction materially.

Steel columns, eaves, struts, and girths, 106,020 lb. @ 8c. erected	.....	$8,481
Concrete columns, eaves and spandrel walls, 132 cu.yd. concrete	$1,980	
21,600 lb. reinforcing steel	1,050	
9,500 sq.ft. forms	1,700	4,730
Difference in favor of concrete	.....	$3,751

Shortly after Walter L. Reid took personal charge we were asked for preliminary estimates for a plant of 2,000 tons' capacity, one-half of the ore to be leached at —35 mesh and the remainder to be treated as a slime. The estimated cost was increased about 28 per cent over the 1,000 ton all-slime plant. Later decisions to give the ore a preliminary wash, to treat the primary slime separately, to provide space for washing equipment ahead of the coarse rolls, and other extras increased this estimate to 34 per cent over our estimate for a 1,000-ton plant.

The cost of the completed mill was $930 per ton of daily capacity (exceeding our estimated cost by 3.5

[1]The United Comstock mill was described in the *Engineering and Mining Journal-Press*, Vol. 114, p. 846.

per cent) including a substation building and its electrical equipment for both mine and mill, the warehouse, refinery, machine and plate shops, assay office, boiler house, and other details, but not including the auxiliary power plant. Of this, 45 per cent applied to buildings and 55 per cent to machinery and equipment. The unit cost compares favorably with that of the average ore-reduction plant, where, in addition to first cost, there is a high fire-insurance rate to be included as a part of the operating expense.

Neither sand nor gravel was available at the plant site, and the cost of opening a quarry and providing crushing and grinding equipment to produce aggregate and sand as well as all the concrete mixing and placing equipment was included in the cost of buildings, no allowance being made for its salvage value. The major quantities involved in the finished job are shown in the first table following. A study was made of non-combustible side-wall materials to determine their relative heat insulation. However, the metallurgical department decided that it would be advisable to heat the mill solutions to about 80 deg. F., and as the radiation from tanks, launders and piping would heat the tank house and possibly the fine-grinding department to a reasonable temperature regardless of the wall material, this feature became of minor importance. The comparative merits of a few of the wall coverings considered are given in the second table following in estimated cost per square foot of wall area and boiler horsepower required to heat the building.

B. P. Little

Excavation, cu.yd.	60,000
Concrete, cu.yd.	15,000
Reinforcing steel, tons	750
Form lumber, bd.ft.	1,200,000
Structural steel, tons	1,000
Glass, sq.ft.	20,000
Machinery and equipment (approximately), tons	3,000
Piping (plant only), miles	18

The boiler capacity required to heat the solutions in winter weather was calculated to be 150 hp., to which should be added about 100 hp. for other parts of the plant. The boiler house was planned for 300 hp., only about 120 hp. of which has been installed. As 20,000 tons of solution is in circulation, the heat contained therein will probably suffice for any ordinary cold snap if the solution is up to normal temperature at the beginning, but it may be difficult to regain lost temperature. A 10 to 20 deg. loss of temperature in solutions seriously lowers the recovery of silver. My observation was that it pays to maintain a minimum of 80 deg. temperature in the solutions. The calculated evaporation from tanks in the tank house averages about sixty tons per day. In cold weather this condenses on the side walls and roof, the humidity being comparable to that of a Turkish bath house. To prevent the formation of ice on the walls in winter, No. 4 construction given in the table was used and proved adequate in 1922-23, which was, however, an unusually mild winter.

Kind of Wall	Estimated Cost per Sq.Ft.	Boiler H.P. Required in Heating Plant
(1) Plain galvanized corrugated steel	$0.140	220
(2) 1½-in. gunite on metal lath	0.196	116
(3) 4-in. hollow clay tile	0.35	93
(4) No. 24 galvanized corrugated steel; 2 plies of 14-lb. tar paper; and inner skin of No. 28 plain galvanized sheets	0.195	125
(5) (Comparison) 1-in. wood sheathing, tar paper and galvanized corrugated steel	0.245	93

The walls were first covered with 28-gage sheets of flat galvanized steel and then with two layers of tar paper weighing about 0.14 lb. per sq.ft., with 24-gage galvanized corrugated sheets outside, all being bolted together at 12-in. spacing with stove bolts and fastened to girt and eave members in the usual way with wire clinches. The smooth sheets inside shed the water readily and light up well, and to date this appears to be a satisfactory construction. During the summer, when the doors and windows are open, the building dries out completely, and this alternate soaking and drying of the roof sheathing may shorten its life. It also loosens the nails holding the corrugated steel roof to the sheathing, and this will necessitate attention.

A decision to build a 2,000-ton plant was made late in June, 1921, and ground was broken July 1. Every effort was made for early completion so as to operate as long as possible under the Pittman Act, which was at the time expected to continue for two years or more. By the end of 1921 the plans were sufficiently developed and machinery deliveries were contracted, so that a time schedule was worked out, and Oct. 1, 1922, was promised as the completion date. By concentrated effort toward the last this date was anticipated by one week. The mill was designed to have a daily capacity of 2,000 dry tons, 60 per cent of which might be either slime or leachable sand.

Providing for the Ore Supply

The coarse-ore pocket was excavated about 25 ft. in the rock. At 20 ft. above the surface a concrete deck 32 ft. wide by 80 ft. long was constructed for carrying two tracks and a revolving car dumper built by the Chicago Car Dumper & Equipment Co., and of sufficient length to dump four ten-ton mine cars at one time. At an angle of repose of 45 deg., the pocket has a live storage capacity of 1,600 tons, but with the sticky ore from the upper part of the mine from which production has come, the live capacity was seriously reduced and varied from day to day, but with "dry ore" (less than 4.5 per cent moisture) about 400 tons can be drawn with little mucking. Ordinarily, without barring, a small chimney will work through from the bottom, and then the ore will cease running. When four cars are dumped simultaneously (in a length of 53 ft.) the ore will pile up to the tipple under the two end cars, and it becomes necessary to uncouple the train and dump only one or two cars at the center. To obviate this, one car section at the south end of the tipple was cut off and an empty car placed between the loads and the switching locomotive, and two cars at a time are dumped without uncoupling.

The ore packs solidly in the pocket if not kept moving, and has to be blasted. To cope with this difficulty

the dumping is made a part of the coarse-crushing program, and two men on each shift operate one of the locomotives and dump the ore. In the interval between ore trains they muck down in the pocket if the crusher plant is running, or assist at odd jobs, or repairing, in the crusher house if that plant is down. On a 1,700- to 2,200-ton basis, the crusher plant is operated on two eight-hour shifts, from noon to 8 p.m., and from midnight to 8 a.m.

When the ore is dry enough not to clog the rolls and permit the undersize to be screened out after passing the rolls, the "easy" capacity of the plant is three tons per minute. It has been tested to four tons per minute for a period of a little more than three hours, the product passing through a ½-in.-mesh wire screen. As there is actually no live storage in the pocket the feed is irregular. There is four hours' accumulation of ore in the pocket when either shift starts crushing, and this is put through as fast as the muckers in the ore pocket can get it in motion. After two or three hours required for this, the feed is intermittent, being dependent upon the arrival of the mine trains. The result is a low power factor for the crushing plant, as the high peak load required to start the rolls militates against shutting them down during the intervals between trains.

To increase the live storage in the pocket sufficiently to insure a steady feed, two alternate installations have been planned and estimated. The more elaborate embodies washing the ore before it reaches the coarse-ore pocket; the other makes use of mechanical feeders in a longitudinal trench to be excavated in the bottom of the pocket. By the latter installation the angle of repose of the ore will be reduced to about 40 deg. and it is expected to develop about 1,100 tons of live storage in the central portion of the pocket. It is possible that when the ore is mined from a greater depth below the croppings it will be more granular and additional equipment will therefore be unnecessary. As a consequence, the suggested changes have been held in abeyance.

The original plan for washing the ore, described hereafter, would not have improved conditions in the ore pocket, as washing was to have been interposed between the head of the pan conveyor which draws the ore from the pocket, and the crushers. However, washing the ore at this point would remove the difficulties of handling it in the crushing department. In conjunction with the mechanical feeders under the ore pocket, this plan would remove most of the difficulties for the least capital expenditure.

The Washing Scheme Proposed

The washing scheme referred to, the structural features of which are included in the present building, provided for taking out —2.5-in. ore through a screen at the head of the pan conveyor, under sprays that would wash the oversize free of most of the adhering slime. The undersize was to be elevated to a trommel screen, the undersize of which, —¼ or —⅜ in., would go to a Dorr classifier, the overflow being the primary slime, the rake product to bypass the rolls and to join the crushed ore stream beyond them. The trommel oversize would join the crusher product and go to the roll circuit. This flow sheet would reduce the quantity of ore now going to the rolls from 20 to 25 per cent, would eliminate much of the fine wood now passing through the rolls, and provide a clean material that would permit operating the rolls with choke feed. It would also eliminate much of the dust that is troublesome in dry weather.

The cost of these additions amortized at 7 per cent over six years, and including maintenance, would add between 1.5 and 2c. to the cost of crushing. The probable saving in operating cost cannot be estimated exactly, as that part of the wear and upkeep caused by the fine sticky portion of the ore cannot be segregated from the present costs. From my observation, I am led to believe that more than half of the wear on conveyor rollers, bearings, and journals is due to the fines, as is also a considerable part of the roll-shell wear, as the clogged screens build up a high circulating load without reducing the final size of product. The soft material appears to have a cushioning effect in the rolls. "Pancakes" a foot or more in diameter and a half-inch thick are not uncommon below the coarse rolls. However, the heat generated in passing and repassing these through the rolls soon disintegrates them. In my opinion 3 to 4c. per ton might be saved over the present cost, or a net gain of 1.5 to 2c. per ton, if the washing now done ahead of the ball mills could be avoided.

If the ore requires, for metallurgical reasons, a preliminary wash, it would seem best to do this ahead of the rolls, but if future metallurgical practice should abandon washing, it is probably best to utilize the existing arrangement for the present and thereby avoid increasing the moisture content in the mill feed. I have never been convinced that preliminary washing is necessary, and I expect to see the practice discontinued eventually, but until this question is definitely settled and experience obtained with the ore from greater depth the present practice of "fighting through" sticky ore in the crushing department is probably justified.

Crusher-Plant Operation

Ore from a chute in the bottom of the crude-ore pocket is received by a 48-in. pan conveyor, 91 ft. centers, and upward slope of 20 deg. The pans are 18 in. pitch length and are made of ¼-in. plate steel, and lined longitudinally with alternate bars of ¼x4-in. flat steel and 2x4-in. maple, the edges being exposed to the wear. The cross axles are 1 7/16-in. cold-rolled steel, with 6-in. cast-iron flanged rollers equipped with Boyer oilers, the centers of the hubs being cored out and filled with felt to provide an oil reservoir. The chain links are ⅜x3½-in. steel, case hardened. The skirt boards were originally 3 ft. 9 in. apart, allowing about 1½-in. spaces between the back of the skirt board and the flanges of the pans. Trouble was experienced by rocks getting into this space and jamming. The skirt boards were moved in to 3½ ft. in the clear, and no further trouble was experienced.

In round numbers the conveyor has delivered 480,000 tons of ore and shows wear as follows: The skirt boards are wearing thin on the lower edges in places and should be turned upside down within the next 400,000 tons. The pans and linings show practically no wear, but some damage has occurred, owing to pieces of mine rails in the feed jamming between the chute and pans. The flanges of the 6-in. rollers have worn considerably, owing to sticky ore adhering to the rails. The original flanges were too thin and broke after a little wear. They are being gradually replaced by new rollers with heavier flanges, but complete replacement will probably require another year or longer. Chains and sprockets show no appreciable wear.

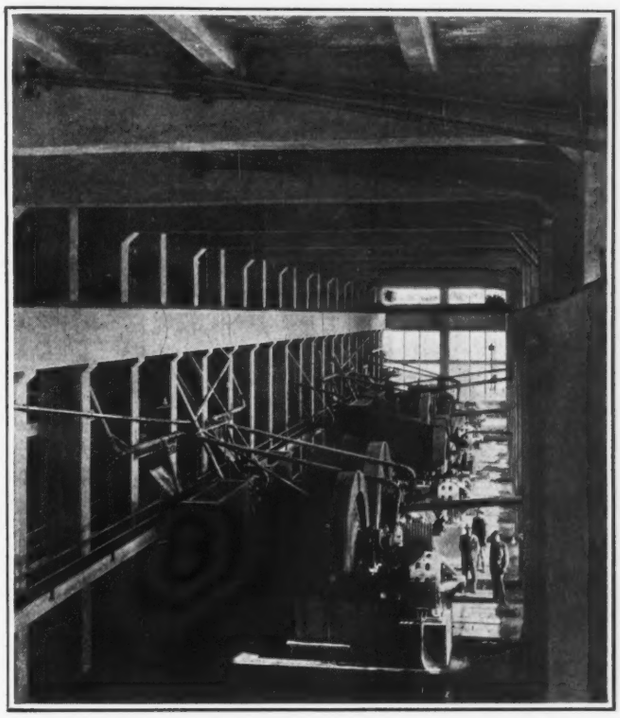
The conveyor is driven by a 20-hp. slip-ring variable-speed motor giving the conveyor a range of speed from 7½ to 15 ft. of travel per minute. The motor is connected through a Fawcus herringbone speed reducer inclosed in a cast-iron case and running in Crater compound lubricant. Except for one or two renewals of lubricant, the speed reducer has required no attention.

In the original plans the pan conveyor discharged upon a traveling bar grizzly designed to remove 2½-in. undersize from the gyratory crusher feed. This machine proved a complete failure, even after the makers had rebuilt it. It was replaced by a stationary grizzly, and later by an impact grizzly of my design, which was also soon discarded in favor of the stationary grizzly. When the ore is dry it screens fairly well on the stationary bars, and when it is wet and sticky it will not screen at all. At times there is an intermediate condition where a mechanical grizzly might help.

The grizzly oversize is passed through one (or both) of two No. 7½ Gates gyratory crushers, style "K," set for 2½-in. ring size. The wear of concaves and heads has been insufficient to obtain a tonnage factor. The concaves are in two sets, one above the other. One lower set has been replaced and a gear and pinion have been worn out, owing to cutting by dust working into the gear chamber. Each gyratory is driven by a 50-hp. G.E. motor at 900 r.p.m., belted direct to the crusher; motors and drives have occasioned no delays. Originally the undersize from the grizzly dropped to a chute feeding a 30-in. belt conveyor (No. 2), but this chute required almost constant attention unless the ore was exceptionally dry. A steel apron conveyor, 48 in. wide and about 12 ft. long, now replaces the chute, receiving the fines and crusher product and delivering to the belt conveyor. This was a decided improvement, but sometimes the ore sticks to the aprons and returns with them to the under side, where it drops off and fills up the clearance spaces and then works into the joints and bearings. The upkeep cost is high. Practically all movable parts were replaced after four months' service. Washed ore would prevent this trouble.

All ore discharged on the No. 2 belt conveyor passes through the 72x20-in. rolls. On its way to the coarse rolls the belt receives the oversize from the screens under the 54x20-in. rolls. Two 42x60-in. Mitchell vibrating screens were installed beneath the 72x20-in. coarse rolls. In August, 1923, these were replaced by two Simplex screens, each 32x54 in., one with ½-in. and the other with ⅝-in. spaces, to determine the most suitable size. The upkeep of the vibratory screens was excessive. They made a great deal of dust with dry ore and were absolutely blind when the ore was wet. At such times the screen frames were removed and the unscreened roll product was delivered to the fine-ore bin. When the ore was at all suitable and the screens were properly maintained they gave a better product for the ball-mill feed, resulting in a substantial saving in the fine-grinding department.

The undersize from the screens is received upon conveyor No. 4, passes through the sampler to conveyor No. 5, and is delivered to the fine-ore bin. The oversize is received on conveyor No. 3, which discharges to one or both of two sets of 54x20-in. rolls, beneath which are four 42x60-in. Mitchell screens, the oversize being received on No. 2 conveyor and the undersize upon No. 4 conveyor. The crushing plant was designed to deliver —¼-in. product to the fine-ore bin and the fine-grinding plant equipment was designed for that feed size. To insure this requirement the 72x20-in. rolls were installed in addition to the two 54x20-in. rolls which we considered might be sufficient. Assuming 25 per cent of the mine ore to be ¼ in. or finer in size, the remaining 1,500 tons would have to be reduced to ¼ in. by the three sets of rolls. At no time within my knowledge were finer than ½-in. screens used and ⅝-, ¾-, and even 1-in. screens were the general practice, the rolls running idle between ore train arrivals and the plant developing only 50 to 60 per cent load factor. Even at that, the power required in the crusher plant



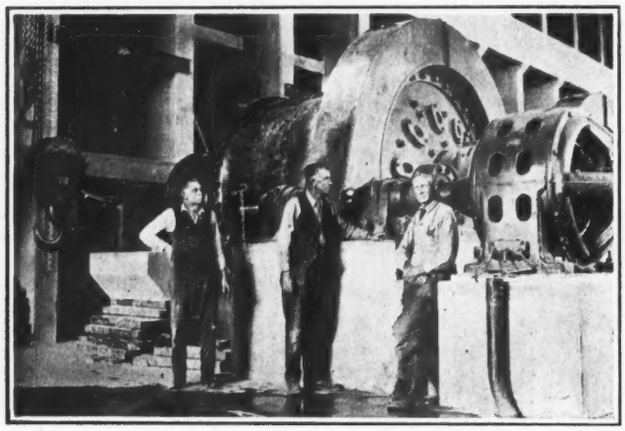
A view in the fine-grinding department; the concentrating floor above

was only 1.81 kw.-hr. per ton at 53 per cent load factor. The ball-mill grinding required 6.36 kw.-hr. per ton at 67.5 per cent load factor. It is obvious that greater economy would have been secured by raising the load factor and delivering a finer product to the ball mills, thus reducing the power requirement of the ball mills as well as wear and tear, and eliminating tramp oversize. The metallurgical tests showed that the preliminary washing should be done at ¼ in. to be most effective in removing cyanicides. If washing is necessary it should have been done at this size.

The 72x20-in. rolls are operated at 85 r.p.m. The shell consumption has averaged 0.055 lb. per ton of ore milled. The 54-in. rolls are operated at 105 r.p.m., and the shell wear is 0.044 lb. each. Total shell wear is 0.143 lb. per ton. Forged steel shells have been used so far, but manganese, cast steel, and chrome steel are to be tried.

A double-strand roller sprocket chain carrying two sample buckets was originally installed to take the initial feed sample cut, the buckets passing through the stream of crushed ore as it fell from conveyor No. 4 to conveyor No. 5. The sample conveyor had horizontal runs of 40 ft. at the top and bottom of the chain

circuit and a vertical run of 40 ft. up one side and down the other. This took the sample below the screen floor and discharged it just under the roof into a hopper which fed to a set of 18x10-in. sample rolls, below which was an intermittent type Vezin sampler taking the second cut and discharging into a sample bin. On normal tonnage this cut was computed to be 1½ tons and remained in the bin until removed by the sample man. It was first drawn from the bin through a second set of 18x10-in. rolls and a Vezin sampler, after which the cut was finished by hand-sampling devices. The chain rollers ran on structural steel tracks. Wear was rapid owing to the dust, causing the chain to give trouble, resulting in burning out first a 3-hp. motor, then a 5-hp., and finally overloading a 10-hp. motor.



One of the 7x6-ft. ball mills, showing direct motor drive

Hand sampling was substituted, and it was quickly found that the chain sampler gave regularly a few cents higher value per ton than the hand sampling.

Investigation disclosed the fact that a little of the fine dust in each bucket dumped would continue to trickle down the hopper after the bulk of the sample containing the coarser particles had passed through the rolls, so that the intermittent Vezin would receive a small amount of fine material on each cut, but would sometimes not cut at the right time to get the coarser particles. Under the circumstances the hand sample was probably the most accurate, but the mining department did not entirely accept this conclusion. The sampling plant was altered by taking out the roller tracks and "draping" the chains over idler sprockets, inserting four sample buckets to reduce the interval between dumps, and improving the method of feeding the rolls. The intermittent Vezin sampler is still an object of suspicion to me, and in my opinion it should be changed to a standard type Vezin by altering the gears.

Among other changes made in the crushing department since starting were the reduction of the speed of No. 3 conveyor belt from about 250 ft. per minute to 150 ft., lessening the spillage, and the installation of a thirty-ton, three-motor electric crane overhead to replace the twenty-ton hand-power crane used during installation of the machinery. The labor required in the coarse-crushing plant has been reduced 50 per cent in the last few months, and in many ways as the operatives became more experienced greater efficiency was noticeable. Nevertheless the total operating cost is still 3 or 4c. per ton higher than it should be.

The United Comstock mill differs from all others in my experience in that the fine-grinding mills operate in closed circuit with concentrating tables instead of mechanical classifiers. The reason given for this arrangement was that the sulphides require longer and somewhat different treatment than the other constituents of the ore, and should therefore be removed at the earliest possible moment, to prevent breaking them down too fine for separation.

The ore is drawn from the 3,200-ton fine-ore bin through any number of twenty-four feed gates on to 24-in. feeder belts which discharge into 54-in. by 16-ft. Akins classifiers used as primary washers. Water is added at the desired ratio of 1½ tons water per ton of ore. This quantity of water is usually exceeded. The primary slime overflowing the classifier weir has amounted to 10¼ per cent of the gross (dry) feed. An average of about 4 lb. of soluble salts per ton has been dissolved out. The ore discharged at the head of the classifier contains about 17 per cent moisture, varying from 15 to 20 per cent. The ratio of water to slime overflowing should therefore be about 11.6:1, but 15:1 is more nearly the actual ratio. The primary slime pulp flows directly to the cyanide plant, and its disposition will be discussed later. The washed ore from the Akins classifiers falls on short 24-in. conveyor belts discharging to the 7x6-ft. Allis-Chalmers grate-type ball mills operated at 9 r.p.m. Mill solution and milk of lime are added to the feed as it enters the mill. Previous to July, 1923, no lime was added to the ball mills. The discharges indicated little or no protective alkali and often gave an acid reaction. The protective alkalinity of the mill solution is maintained at about 1½ lb. lime, and cyanide at 2 lb. NaCN per ton solution.

The ball-mill discharge is received by a 15x8x26-ft. Dorr bowl classifier (one for each of the two 1,000-ton units), the overflow (—100 mesh) going to the secondary slime treatment. The rake product is elevated to a point above the table floor, each elevator discharging into two hydraulic classifiers (in parallel), the spigot products of which are supposed to be oversize and return to the ball mills after dewatering in Model C 4½x16-ft. Dorr classifiers, one classifier serving two 7x6-ft. ball mills. The hydraulic classifier overflow is the table feed. Fifteen Deister Plat-O tables serve each 1,000-ton unit. The table flow was equipped with eight additional hydraulic classifiers in each unit to admit of classifying the table feed. The rougher tables were intended to take off an oversize as middling to be returned to the ball mills, a concentrate which went to a ball-peb mill for regrinding, and a sand tailing suitable for the leaching plant. The fine tables were to make concentrate and sand.

No single feature of the flow sheet caused as much difference of opinion as the concentrating-floor layout, particularly the sixteen hydraulic classifiers and the accessory sixteen 5-ft. settling cones. Many visiting engineers were interested but not favorably impressed.

In operation, the following difficulties developed. The single pass through the ball mills allowed oversize up to ½ in. to pass. The receiving pair of hydraulic classifiers could not remove all the oversize down to —35 mesh (much +10 mesh material was present in the overflow), and the first four to six tables could not make a sand suitable for leaching. However, a small amount of concentrate was obtained from them, and the remainder of the table feed treated as oversize middling and returned to the ball mills, a considerable part of which was already fine enough. The ten classifiers in

each unit required such a quantity of "hydraulic" solution for the spigots that the tables were flooded and deprived the bowl classifiers below of clear solution for backwash. This had to be made up by using the overflow of the dewatering (Dorr) classifiers as backwash for the bowl classifiers and to wash the rake product to the elevator boots. This solution contained considerable slime, much of which was ultimately received by the leaching tanks.

These difficulties were not so apparent nor serious in the first operating months when the tonnage was low, but as the monthly tonnage approached and passed 40,000 tons they began to affect the efficiency of the mill. The first change was made in June, 1923. The discharge ends of the ball mills were fitted with conical-shaped trommels attached to the trunnion flange, leaving sufficient space between the discharge lip and screen to sample the mill discharge. A sand wheel was built into the outer (large) end of the trommel to sand is more in the unclassified feed by about 5 per cent, which is more serious. On the whole, the unclassified feed showed so many operating advantages that the south unit was afterward changed over. The 200-mesh ore is present in about equal proportions in both units, according to the tests. This is objectionable, as it contains fine sulphides that do not yield readily to leaching, and the fine material retards the leaching of the sand.

The concentrate separated on the tables averages 1.6 per cent (in weight) of the gross feed and contains about 17½ per cent of the head value of the ore. It yields, on treatment in the cyanide department, 92 to 95 per cent of its values. As the cost of elevating and concentrating adds less than 4c. per ton to the cost of ore treatment, question can hardly be raised as to the advisability of concentrating. The elimination of over- and undersize from the table feed is necessary, and the ball mills should work in closed circuit with

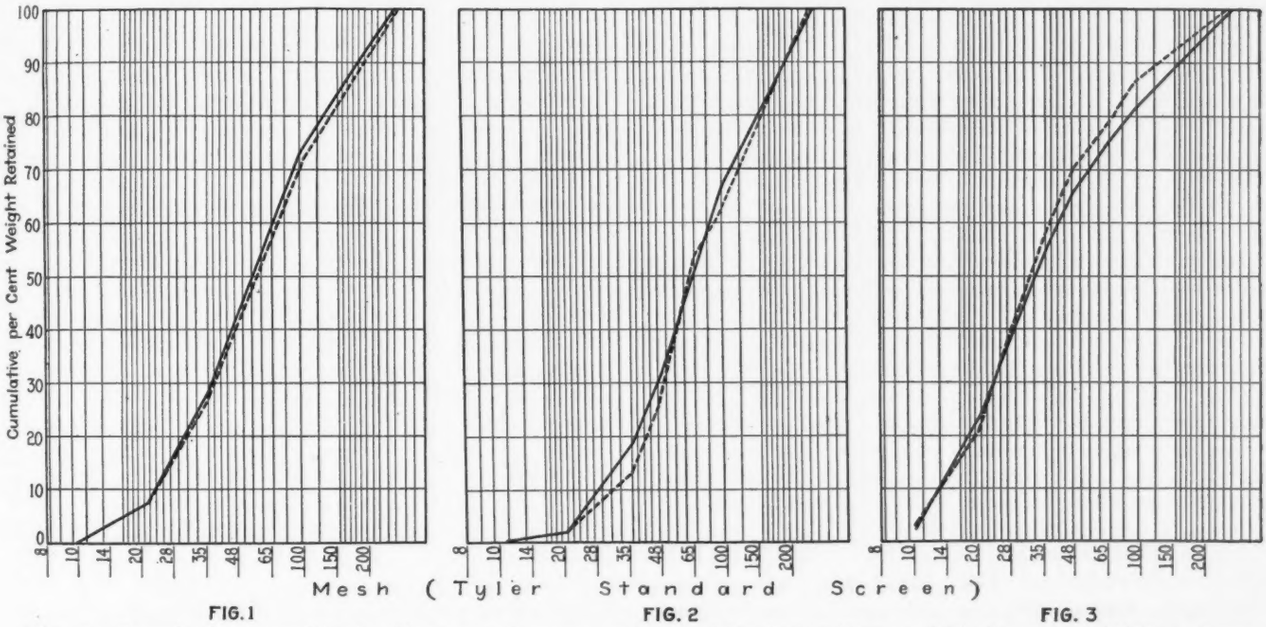


Fig. 1—Cumulative logarithmic diagram of screen anlysis of bowl classifier sand discharge. Solid line shows feed for unclassified tables; the dotted line, feed for classified tables. Fig. 2—Table tailing leach sand. Solid line shows tailing from tables with unclassified feed; dotted, from tables with hydraulically classified feed. Fig. 3—Table middling. Solid line—table feed unclassified; dotted line—hydraulically classified.

elevate the oversize and discharge it into a launder leading into the Model C classifier alongside. The coarser oversize is therefore in closed circuit. Each of the trommels carries about 27 sq.ft. of sheet metal screens with $\frac{3}{16}$-in. perforations. (They are performing the service designed to be done by the Mitchell screens in the coarse-crushing department.) The undersize of these screens is received by the bowl classifiers and gives less trouble at the hydraulic classifiers above the table floor. Recently, in the north unit, all the classifiers and settling cones except the two hydraulic classifiers into which the elevators discharge were bypassed and each of fifteen tables received equal parts of an unclassified feed.

When tuned up to this new condition a careful sampling was made of the comparative work of the two units. The screen tests are shown above.

The tailing from classified feed was about 6c. per ton lower than that of the unclassified feed. This is not so important, but the proportion of +35 mesh mechanical classifiers that will eliminate all +35-mesh ore from the table circuit. This would relieve the tables of their present circulating load and should result in a higher recovery of sulphides and a better leaching sand.

The Dorr classifiers at the ball mills were to be used as dewatering devices only, and are too small for closed-circuit classifiers. Rearrangement and new equipment will be necessary to rectify the flow sheet, but the improved recovery in the leaching department would be immediate and important enough to justify the change.

The +35-mesh sand, after leaching, contains about 1 oz. of silver per ton, over half of which can be recovered if the sand is reground and retreated. The original ball-mill table circuit seems to me inferior to the standard method of closed circuit with mechanical classifiers, although possibly not with a high or rich sulphide content in the ore.

The table concentrate flows to a 5x12-ft. tube mill (2-in. steel balls), passing first an automatic sampler

and then through a 42-in. by 14-ft. Akins classifier used as a dewaterer. The tube mill discharge is pumped back to the table floor and fed to two Deister Plat-O fine tables functioning as sizing classifiers; —300 mesh flowing across the table to the tailing launder, the other "take-offs" being returned to the tube mill through the dewaterer (but not through the sampler).

The arrangement works so well and gives such good results that it seems unnecessary to criticise it, but, on the other hand, if the tube mill were closed-circuited with a mechanical classifier adjusted to overflow at —300 mesh, the same result would be obtained at less expense for power and upkeep and two additional concentrating tables could be used on direct feed.

Only a few features of the mechanical equipment require mention. So far as practicable belting was eliminated and direct drives were used. The ten 54-in. by 16-ft. Akins washing classifiers are arranged in two groups of four each and one group of two. Each group of four is driven by 15-hp. motors at 900 r.p.m., direct-connected to a 20-hp. Foote Bros. spur-gear speed reducer, carrying two belt pulleys on its slow-speed shaft, which are belted direct to the pinion shafts of the classifiers, two classifiers being driven by one pinion shaft. Either may be disconnected by means of jaw clutches on the pinions. The group of two is similarly arranged. The motor is 7½ hp. and the speed reducer is 10 hp. Similar speed reducers are used to drive the two sections of line shafting from which the feeder conveyors and classifiers are belted. These speed reducers have operated one year without trouble except occasionally to replace the felt oil retainers in the gear cases. There is opportunity for the manufacturer to improve the machines in this respect.

The washing classifiers were equipped with plate-steel worm flights. These wore out rapidly. Replacements are being made with hard cast-iron flights of our own design, and a drop in the upkeep expense of the machines is already apparent, but it is not yet possible to state a tonnage upkeep cost.

The ball mills are driven by 150-hp. motors at 360 r.p.m., direct-connected to the pinion shafts with flexible couplings. The main gears and pinions are herringbone gears. These drives are giving excellent service. Ball consumption is 1.91 lb. per ton of gross dry mill feed, and liner consumption (white cast iron) 0.48 lb. per ton. Power consumption is 6.35 kw.-hr. per ton gross feed, or practically 7 kw.-hr. after deducting primary slime.

The bucket elevators are 30-in. belts, 70 ft. vertically, center to center of head and boot pulleys. The buckets are 8x18-in. malleable cast iron at 18-in. pitch, staggered. Three elevators operate at 312 ft. belt speed and one (experimentally) at 400 ft. per minute. The lower-speed elevators discharge as satisfactorily as the high-speed one. The boot pulleys and frames conform closely to the design first worked out by George Bradley, and used extensively by Bradley, Bruff & Labarthe in their mill designs. An improvement was made by making one end of the boot pulley shaft adjustable vertically in relation to its frame, the purpose being that near the end of the life of a belt, when it begins to stretch unevenly, this adjustment might secure a few extra weeks' service from the belt.

Four different belts were installed, a Manhattan, Goodrich, Boston, and Victor Balata. Little or no deterioration can be observed in any of them in one year. The head pulleys and shafts are of unusual design and follow closely an idea developed by Gerald H. Hutton, manager of the dredging department of the Metals Exploration Co., for attaching main tumblers to driving shafts. The head-pulley shafts are 7½ in. in diameter for a short length at the center, and then taper both ways down to 6 in. at the journals. The pulleys have long hubs which fit loosely over the central part of the shaft and extend out over the tapers. Fastening is made by a pair of split tapered quills with flanged ends outside the hubs, and through these flanges and between the pulley spokes pass bolts by means of which the quills are drawn together from opposite ends of the pulley hub, wedging inside the projecting hubs. Keyseats are unnecessary (though used); the pulley is held solidly, and if it is necessary to remove a pulley from a shaft it can be done quickly and easily. The elevators are each driven by 30-hp. motors direct-connected through Fawcus herringbone-gear speed reducers to the head shafts. These reducers seem to be perfect and consume little power. Three of the motors run at 900 r.p.m. and one runs at 1,200 r.p.m.

The lime-grinding plant, supplying the protective alkali, is in the south end of the fine-grinding department. A 200-ton storage bin receives the lime as it is unloaded from cars, the lump lime being shipped from California. The lime required is 16½ lb. per ton of ore milled. From the storage bin it is drawn through a 17x10-in. Blake crusher (previously used to crush concrete aggregate) into a measuring hopper, from which it is fed by a Challenge feeder to a 3x6-ft., trunnion feed and discharge, ball mill. It is ground in mill solution to a dilute milk of lime, which is laundered to numerous points in the fine-grinding and cyaniding departments, wherever lime is added. The ball mill is direct-driven through a Foote Bros. spur-gear speed reducer by a 15-hp. motor. This drive has also proved satisfactory. Originally, a 42-in. by 14-ft. Akins classifier was installed between the Challenge feeder and ball mill, in which solution was added to slake the lime before it entered the ball mill, but this proved unnecessary, and the present arrangement is better. Only part of the time of one man on each shift is required for operation. He receives instructions to run in a certain number of batches during his shift of eight hours. Filling the measuring hopper requires only three or four minutes, after which no further attention is necessary for an hour or two.

The fine-grinding and concentrating department requires from sixteen to eighteen men in the three shifts, for operation and repair. In recent months the labor was 0.008 man-shifts per dry ton of ore milled. The total power consumption was 8 kw.-hr. per ton, exclusive of lighting, which requires from 9,000 to 11,000 kw.-hr. per month.

Wood launders lined with concrete were adopted as standard construction, and after one year show little or no wear. The coefficient of friction is as low as that of cast iron. In designing the mill, a launder slope of 1¼ in. per foot determined the relative elevation of the various floors and departments. The hydraulic classifiers were introduced into the design after the elevators were built, and the mill head required for them had to be stolen from the table feed launder slopes, thus materially reducing the grades and giving trouble at first. This was gradually overcome. The 1¼-in. slope adopted appears to be just right, though possibly 1⅛ in. per foot would have sufficed.

Information Obtainable From Churn-drill Sampling

Forms and Methods Used in Collecting and Compiling the Data Recorded From Prospecting Samples

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THE ONLY REASON for churn drilling an orebody of copper or any other metal is to obtain samples from various points within the orebody. From such samples, a variety of information is derived, including copper content, the form in which the metal occurs, the metals and minerals with which it is associated, and other characteristics of the orebody. Given data furnished by the samples, then by a series of calculations a deduction is made as to whether or not the orebody possesses ore sufficient in quantity and grade to become the basis of a profitable mining enterprise.

In making such a deduction, since the churn drill samples are the only or at least the most important source of information, it is important that they be made to yield the greatest possible amount of information. The chemist, churn driller, and geologist may each be called upon to testify, and data which each worker may furnish have nearly equal value. Compiling and recording all data in a handy and available form, besides properly interpreting such data, makes far more certain and easy the final important deduction.

Object Is to Obtain All Information Possible

Having spent some few years in procuring, assembling, and recording the data obtained from churn-drill holes, I have worked out a system for handling the work which in practice has been found to be efficient. It is not to be understood that this system is applicable to any and every condition, but I do believe that properly modified and intelligently handled, it will give far more complete data concerning an orebody than is usually obtained from the haphazard way in which churn-drilling campaigns are sometimes handled, which applies not only to the methods used in obtaining the data but also to the method of recording and keeping a permanent record of the work.

Fig. 1 is the ledger sheet on which the complete record of one hole is assembled. There is not space enough, upon a single sheet of handy size, for the logs of deep holes, so all sheets are made up of a standard size for binding, and as many sheets as necessary used to complete the log of a hole of great depth. The foil sheets, however, do not need to carry the same complete heading carried by the first sheet, sufficient for them being the heading "5 Ft. Samples, etc."

If a photostat machine is available for copying, the forms for both first and second sheets may be got out by a printer, of a size about 14x20 in. inside of a margin about two inches wide at the left for binding. If a photostat machine is not available, the forms must be made on tracing cloth, either by a printer or draftsman. When all the data pertaining to a hole have been posted on the form, as many copies as desired can be made in white or colored prints by direct or indirect methods of printing. In any case, the form made up on tracing cloth is preferable, for the reason that it is more permanent and it can be either directly printed or photostated with equal facility. The only argument against using the tracing cloth form is that tracing cloth is slightly more expensive. The forms are made all of the same size, and when filed in a ledger binder, No. 1 should be against the back cover, so that the pages read in reverse order to that of an ordinary book. By this method of filing, any particular page desired can be found just as easily and wear and tear of handling and removing are prevented. If working copies of the ledger are needed, extra copies may be made in white or colored print, thereby keeping the original copy and permanent record in better condition.

An Elaborate Record Can Be Kept

On Fig. 1, in the upper left-hand corner are the coordinates of location and the elevation above sea level of the collar of the hole. In the upper right-hand corner in large figures is the number of the hole, which makes it easy to find any particular hole desired in the ledger. The first line of the heading shows the date the hole was started, the date stopped, total days drilling, the depth which the hole attained, and the average feet per day drilled. The second line of the heading gives data concerning the encountered water level, its depth in the hole, and elevation above sea level. The third and fourth lines give data regarding the depth of capping, if any, and the thickness, character and grade of both oxide and sulphide ore. In these lines with the character qualification, "Regular, Spotted, and Very Spotted," it is simply necessary to cross out the inapplicable terms and leave the applicable. The fifth and sixth lines tell what the hole did, why it was stopped, and whether it should or should not have been drilled deeper, and the last lines give the conclusions reached about the hole.

Under this heading an attempt has been made to give a synopsis of the pertinent data regarding the hole made out on a form which can be completed by simply crossing out the inapplicable matter. It is necessary to have all this so that data may be entered on the form as fast as received from the various sources of information, and when all data are finally in the office, a suitable heading can be made out in a few minutes. Of course the man in charge of the work must classify the hole and cross out the statements which do not apply. In this work it is better to cross and blot out completely unnecessary and superfluous matter, so that no mistakes may be made in reading, which has not been done in the example given, in order that the entire matter might be left readable.

The data obtained from the assayers occupy the left-hand side of the ledger page. The first column on the left-hand side of the page is a part of the form as first made up, since that column will be the same for

Co-Ords.
N 4626.72
E 3576.21
Elev. 2136.22

CHURN DRILL HOLE RECORD
LA FINCA EXPLORATION

NO. 71

Spudded Mar. 3 1923 Stopped May 7 1923 Days drilling 65 At depth of 1275 ft Average 19.45 ft per day Water level at depth of 175 ft From collar at elevation of feet 1951.22 ft above sea level hole nos. 700 ft of barren capping 750 feet of oxide ore, Av 1.45 % Cu, Character Regular – ~~Spotted~~ ~~Very spotted~~. Sulphide ore from depth of 1750 ft. to 3500 ft total thickness of 1750 ft Av 1.81 % Cu. Character – Regular – ~~Spotted~~ ~~Very spotted~~. Passes into low grade primary ore ~~Stopped ore~~ ~~Was lost~~ – Stopped ~~On account lost string of tools~~ ~~Casing~~ ~~Caving~~ – Intentionally – Passed through ore – Low values Should have been drilled no deeper
Data obtained from this hole Good · Fair Poor Worthless
Cased from 0.00 ft Depth to 1270.0 ft. Depth – Drillers W L JOYCE M J MURPHY
Assayers L F CLARK E V HERRING
J E NARDING ..... GEOLOGIST

5 FT. SAMPLES			Av of 3AM		COMPOSITES								LOG	DRILLERS REPORT		GEOLOGISTS REPORT			
Depth	Tot Cu	Sol Cu	Tot Cu	Sol Cu	Tot Cu	Sol Cu	Fe %	Al_2O_3 %	Co %	S %	Insol %	Acid Con lb per ton		DAYS	FORMATION	METALLIC MINERALS	NON-METALLIC MINERALS	FORMATION	
5	000														Gravel	Limonite			
10	000														"	"			
15	000														"	"			
20	000														"	"			
25	034	009													Limestone S	Malachite	Calcite, Quartz, Kaolin		GRAVEL WASH
30	031	009												1	" "	" "	" " "		
35	032	009	035	007	035	001	113	286	1021	007	4360	40			" "	" "	" " GARNET		Hornfels Metamorphosed to Quartzite Brecciated-Kaolinized and Sericitized Slightly Mineralized
40	039	005													" "	" "	" "		
45	038	003													" "	" "	" " SERICITE		
50	065	004													" "	" "	" "		
55	048	005												2	" "	" "	" "		
60	043	013	047	010	049	005	167	242	1108	008	4220				" "	" "	" " EPIDOT		
65	045	012													" "	" "	" "		
70	034	016													" "	" "	" "		
75	109	081												3	" "	" "	" "		
80	156	131													" "	" "	" "		CONTACT DIP N.W. ST N 27 30E 68°
85	159	132	134	107	129	109	132	1612	696	017	7920	128			Porph Soft	Azurite	Quartz, Kaolin, Sericite		
90	167	143													"	"	"		
95	077	048												4	"	"	" BIOTITE		
100	145	117													"	"	"		
105	120	092													"	Chrysocolla	"		
110	131	103	149	121	156	111	106	1420	472	016	7640	120			Medium	"	"		
115	167	139													" "	"	" HORNBLENDE		
120	183	155												5	" "	"	"		
125	170	130													" "	HEMATITE, MALACHITE Limonite, copper, pyrite	"		
130	137	097													" "	Limonite, malachite	"		
135	153	113	152	112	134	111	101	1370	321	017	7520	128			" "	"	"		
140	156	116												6	" "	" Cuprite	Qu Ka PLAGIOCLASE, ORLEIOCLOSE		
145	146	106													" "	"	Pl Or. Hb Bi		
150	093	072													" "	"	"		
155	060	039													" "	"	"		
160	046	025	074	053	011	045	106	1280	318	018	7260	80		7	" "	Nat Cu	" CHLORITE		
165	027	006													" "	CUPRITE MALACHITE	"		
170	142	121			Top of Mixed Oxide and Sulphide										SULPHIDE	MALACHITE CHALCOCITE, PYRITE	"		
175	109	050			Water Level - Elev. 1951.22										" WATER	" "	"		
180	254	047													" "	BORNITE	"		
185	350	053	293	050	276	066	093	996	194	131	7430	64		8	" "	"	"		
190	304	046													" "	"	"		
195	446	054			Top of Sulphide										" "	"	"		
200	418	012													" "	PYRITE, CHALCOTITE	"		
205	347	016													" "	"	"		
210	462	008	461	012	457	008	148	842	181	263	6970	32		9	" "	"	"		
215	494	008													" "	"	"		
220	582	016													" "	"	"		
310	171	006	163	008	167	002	230	1116	152	242	7430	48			" "	ARSENOPYRITE, ENARGITE			
315	157	010													" "	PYRITE			
320	141	008												15	" "	"	"		
325	141	001													" "	Mard	"		
330	146	005												16	" "	"	"		
335	140	002	130	003	129	004	122	1412	161	135	7360	95		17	" "	"	"		
340	105	004													" "	Medium	PYRITE, CHALCOPITE		
345	116	003													" "	"	"		
350	073	004													" "	"	"		
355	105	002												18	" "	"	"		
360	102	002	098	004	093	002	106	1420	154	106	7440	112			" "	"	"		
365	099	003													" "	"	"		
370	110	001												19	" "	"	"		
375	124	006													" "	"	"		
380	118	008													" "	"	"		
385	116	007	115	007	118	001	166	1580	151	190	7620	105		20	" "	"	"		

MONZONITE Metamorphosed Oxidized Silicified Kaolinized Chloritized Copper Complex Oxidized

Rock has been pervasively and silicified with deposition of both primary and secondary Copper 98 % Sulphide form. Mineral mostly Chalcocite

Fig. 1—The complete record

all holes. The assayer reports his results on forms in Fig. 2 and Fig. 3, the former printed on green paper and the latter on pink paper for greater ease and accuracy in filing.

The form Fig. 2 should have about ten lines as space for placing all the assays that may be necessary for a day's drilling. At the end of each day's drilling. all samples procured should be delivered to the assayer, and he should never be more than one day behind with his results. It is in the highest degree important that the assaying work should always keep up with the drilling so that information from that source is immediately available. If it is necessary to know the content of any particular sample before others, that sample may be sent to the assay office with a priority order and assayed without drying, to expedite the matter, but such samples are inexact and should not be considered as final assays.

On the form Fig. 2 the assayer reports values in both total and soluble copper, the total copper, the result

of an assay by the regular potassium iodide determination, and the soluble copper by an entirely different determination.

The method of determining soluble copper is briefly as follows: Two grams of pulp at 80 mesh are left overnight in 10 cc. of a 12.3 per cent solution of sulphuric acid. In the morning the mixture is filtered, 10 cc. of a solution of sodium thiosulphate carrying 300 gm. per liter is added to the filtrate, and that mixture boiled until the resulting sulphides are coagulated. Then the mixture is again filtered, and the filter paper and contents burned in a scorifier. To the ash is added 2 cc. of concentrate nitric acid and a small amount of potassium chlorate, and this is heated on a stove to the consistency of syrup. Diluted to a volume of about 10 cc., ammonia is added to precipitate copper and redissolved to blue solution. Then the solution is again heated until precipitate begins to form, when about 2 cc. of acetic acid are introduced and the solution is diluted to a volume of about 15 cc. and cooled, after which one or two grams of potassium iodide are added and the solution is titrated with a standard solution of sodium thiosulphate.

A Parallel in Metallurgical Processes

Thus determined, soluble copper, in addition to the copper contained in the sample in the form of carbonates, etc., includes a small portion of that contained as sulphides, about half the copper contained as cuprite and a minute portion of any native copper that there may be. Although not entirely accurate, this method gives a close approximation of the recovery of copper which may be obtained by leaching the ore in a large-sized plant by the standard sulphuric-acid process.

Fig. 3, printed on pink paper, is the form on which the chemist reports his analyses of composite samples. It so happens that for the hole shown on the sheet, Fig. 1, the composites were made up each of five samples, starting in at the top of the hole. This method can be improved upon. A better method to follow in making up composites would be, first, by an inspection of the assay results of the hole to determine the location of the various ore zones in the hole. Then make up the composites, to correspond with the various ore zones. It is a question whether to make up the composites covering an entire ore zone, or to split up the ore zone into an even number of samples. By making up a composite to cover an entire zone the work of the assayers would be considerably lightened, but it is a question whether to depend upon a single assay and a single composite or upon the average of several assays and as many composites. I should prefer, in case the assayers are able to handle the extra work, to have the composites made up of, say, five samples throughout the ore zones, and average the results, rather than of one single composite of an entire zone. In any case a few trials of both methods would easily determine if the results obtained by the extra work are warranted.

(Color, green) *LA FINCA EXPLORATION* *HOLE No.* 71

CHURN DRILL HOLE RECORD

Assayer's Report *5 Ft. Samples*

D. N. No.	*Samp. No.*	*Assay Office No.*	*Tot. Cu.*	*Sol. Cu.*
71	240	11216	3.12	0.16
71	245	11217	3.03	0.20
71	270	11312	3.00	0.12
71	275	11313	2.70	0.08
		Assayer *E. Y. Herring.*		

Fig. 2—Assayer's report on 5-ft. samples

Checks on the Work

It will be noted that the arithmetical average of five samples in both total and soluble copper, shown on Fig. 1, do not check with the assayed value of the composites. This is quite to be expected, but these differences give an excellent check on the care with which the composites are made up, as well as the quality of the work done by the assayers.

These composites were, besides copper, assayed for iron, alumina, sulphur, lime, and insoluble, in addition to the amount of acid consumed theoretically by a ton of ore. With this data as a basis, close calculations may be made as to the behavior of the ore when subjected to processes of metallurgy. For instance, knowing the amount of soluble copper carried by the oxide ore, as well as the insoluble copper and the acid-consuming agents, close calculations may be made of what may be attained in a standard-process leaching plant, in the line of probable metallurgical recovery, acid consumption and other details. In the matter of sulphide ore, by the same data it is possible to calculate

(Color, pink) *LA FINCA EXPLORATION* *HOLE No.* 71

CHURN DRILL HOLE RECORD

Assayer's Report *Composite Samples*

Assay Office No.	Drill Hole No.	Samples From	Samples To	Av. of 5 Ft. Samples Tot. Cu.	Av. of 5 Ft. Samples Sol. Cu.	Composite Sample Analysis Tot. Cu.	Sol. Cu.	Fe	Al_2O_3	CaO	S	Insol.	Acid Con.	Acid Consumed By
12962	71	225	245	3.78	0.20	3.53	0.08	2.10	10.20	1.72	2.70	73.26	64	$CaCO_3$ Al_2SiO_3 Cu
12963	71	250	270	2.35	0.12	2.35	0.04	1.79	10.21	1.56	2.11	82.10	32	$CaCO_3$ $Fe(OH)_3$
13721	71	325	345	1.30	0.03	1.29	0.04	1.22	14.12	1.61	1.35	73.60	95	$CaCO_3$ $Fe(OH)_3$ $AlSiO_3$
13722	71	350	370	0.98	0.04	0.93	0.02	1.06	14.20	1.54	1.06	74.40	112	$CaCO_3$ $Fe(OH)_3$
								Assayer		*L. F. Clark*				

Fig. 3—Assayer's report on composite samples

the amount of copper which should be recovered by concentration, and quite closely what the composition of the concentrate will be.

It is not to be understood that such calculations have great value when uncorroborated by the results of an experimental plant, but they are valuable as information as to what may be expected from such a plant.

Under the heading "Log," Fig. 1, is a graphic chart showing the location of ore and waste as well as the footage and grade corresponding to each one. On this particular job divisions were made as follows: 0.0 to

(Color, yellow) *LA FINCA EXPLORATION* *HOLE No.* 71

CHURN DRILL HOLE RECORD

Driller's Report *Hole No.* 71 *Samp. No.* 245

Time Actually Drilling Sample 16 Hours

Character of Rock Very Hard Quartz-Porphyry

Minerals Pyrite, Bornite, Chalcopyrite

Casing Down To Sample *Day Drilling* 12th

Remarks: This Sample Came From Hardest Rib We Have Struck. Drilling Very Slow. Brake Set of Jars Will Change To Wire Line If Does Not Get Softer.

Jan. 23, 1923 *Driller* W. L. Joyce

Fig. 4—Driller's report

0.5 per cent; 0.5 per cent to 1.0 per cent and 1.0 per cent and above, in both sulphide and oxide ore. In other circumstances it might be desirable to make divisions of ore at closer intervals of grade, which is just as easily done. The use of this log is merely to furnish a graphic chart which shows at a glance the quantity and grade of ore in a hole.

In making up the divisions, a limit must be set upon the least number of samples permitted to form a division in any separate grade. To avoid a large number

(Color, white) *LA FINCA EXPLORATION* *HOLE No.* 71

CHURN DRILL HOLE RECORD

Geologist's Report *Hole No.* 71 *Samp. No.* 245

Formation Manzonite

Metallic Minerals Pyrite, Chalcocite, Bornite, Chalcopyrite

Non Metallic Minerals Quartz, Kaolin, Sericite, Plagioclase Orthoclase, Hornblende, Biotite, Chlorite

Remarks: Under Microscope This Sample Seems To Be From a Very Hard, Highly Silicified, Phanerocristalline Phase Of Manzonite. Probably a Very Hard Rib Which Supported An Overthrust Fault.

Geologist J. E. Harding

Fig. 5—Geologist's report

of divisions, and undue complexity in the work, it is advisable to limit such zones to five samples. Any division might contain some samples of such a grade that they should fall in another division, but if the average of five determines a section of a hole for any particular division, then the majority, that is the average, must rule.

The Churn Driller's Report

In the middle of the page, Fig. 1, is the column headed Churn Driller's Report. For compiling data under this heading, the form Fig. 4, printed on yellow paper, is furnished, which the churn driller makes out for each sample and sends to the central office. On this form he notes the time spent in actually drilling the sample, character of rock penetrated, minerals he notes in the sample, whether hole cased or not, and any remarks concerning formation which may occur to him. In many cases it will be unnecessary for the driller to fill in more than the statement of actual time spent in drilling the sample, as the other data will be merely a duplication of that on the sheet of the previous sample; in which event he merely writes across the lines below, "Same as last sample."

The final heading in Fig. 1, Geologist's Report, is one on which a large amount of thorough and careful work must be done. Its value depends entirely upon the ability of the geologist to interpret, in terms of underground conditions, the suggestions which a small amount of crushed material may make to him.

As a preliminary to work on the actual samples, the geologist should make a careful surface map of the ore deposit, with especial reference to contacts, faults, and all other structural features, so that when a hole is started he is in a position to know fairly closely not only the various formations which the hole will pierce but also the points at which contacts and faults should be encountered. The particular work on which this sheet was made out was on a small intrusive stock of monzonite in a complex of older porphyries, sedimentaries, and lava flows, a geological condition which would not fit at all the average low-grade copper orebody. Nevertheless, whether a deposit be of the direct intrusive, contact metamorphic, or impregnated type, the geological structure will have an important bearing on the deposition of the ore, and the greatest care should be taken clearly to understand and delineate such geology.

Geological Notations Are Made

Fig. 5, printed on white paper, is the form on which the geologist reports the result of his examination of each sample. It is entirely unnecessary to make a microscopic examination of each sample, since in the majority of cases a simple examination with a hand lens is sufficient to determine the minerals contained in the sample. Cases will arise in which a hand lens is insufficient, and then the microscope must be used. If the particle of mineral in doubt is sufficiently large, and of such character that the index of refraction can be determined, this index will usually suffice to determine the name of the mineral. In the case of doubtful sulphides, their cleavage and appearance under reflected light is usually sufficient to determine the classification. Blowpipe determination of fragments of large size is also sometimes useful.

In an oxidized zone, rare minerals are sometimes encountered, but these rare minerals are generally so small in amount that interest in them is more academic than economic. In almost all copper orebodies minerals of lead or zinc are to be found, but these too are generally unimportant. The geologist should be on the lookout for oxidized arsenides and arsenates. These minerals generally stand out clearly from the more common oxides, and the presence of arsenic is not detected by the routine methods of assaying for copper.

In the zone of transition from oxides to sulphides, usually some rather interesting and varied mineralization is encountered, and anything of interest in this matter should be noted on the sheet.

In the sulphide zone, the microscope must be used more frequently in determining exactly how important a rôle secondary enrichment has played in the scheme of

mineralization. By the use of a screen an index can be worked out, which will show the proportion of the various sulphide minerals in the sample. As the hole gets deeper into the sulphide zone, evidence of epigenetic mineralization disappears, and finally it develops that only syngenetic minerals are to be noted. At about this point, as a rule, the assayers are reporting low values in copper, and it is time to look about to see where the next set-up will be.

For the purpose of determining the formation, the non-metallic minerals are of far more importance than are the metallic. It is not the purpose of this article to go into methods of determinative petrography, but any experienced geologist will have at his command the implements and skill required to determine the major constituents of any particular rock with which he is dealing.

As between sedimentary and igneous formations, there is no difficulty in making a determination. Generally the color of the churn-drill sludge is sufficient to settle that matter. Between two similar porphyries the determination is by no means as simple. Generally, however, some different feldspar, or some difference in proportion of ferromagnesians, will give a clew from which a norm may be worked out, which will distinguish between two porphyries, even though to the eye they may be similar. Every orebody presents a different problem and such a problem can only be worked out on the ground.

When a hole is finished and all data are posted, the forms Figs. 2, 3, 4, and 5 may be either thrown away or filed, for the reason that Fig. 1 carries all the information from the four others, and seemingly carries by itself the complete record of the hole. It may seem that this system is somewhat cumbersome and expensive, but some record must be kept, and nothing is added to the cost of the work by making the record so complete.

At some time or other sections of the orebody must be made up from the data furnished by churn drilling, and for that work, if the sections are to be of any value, every possible source of information must be drawn upon. For that reason an attempt has been made to record on a convenient form every possible bit of information which may be extracted from a churn-drill hole.

Corocoro's Flow Sheet

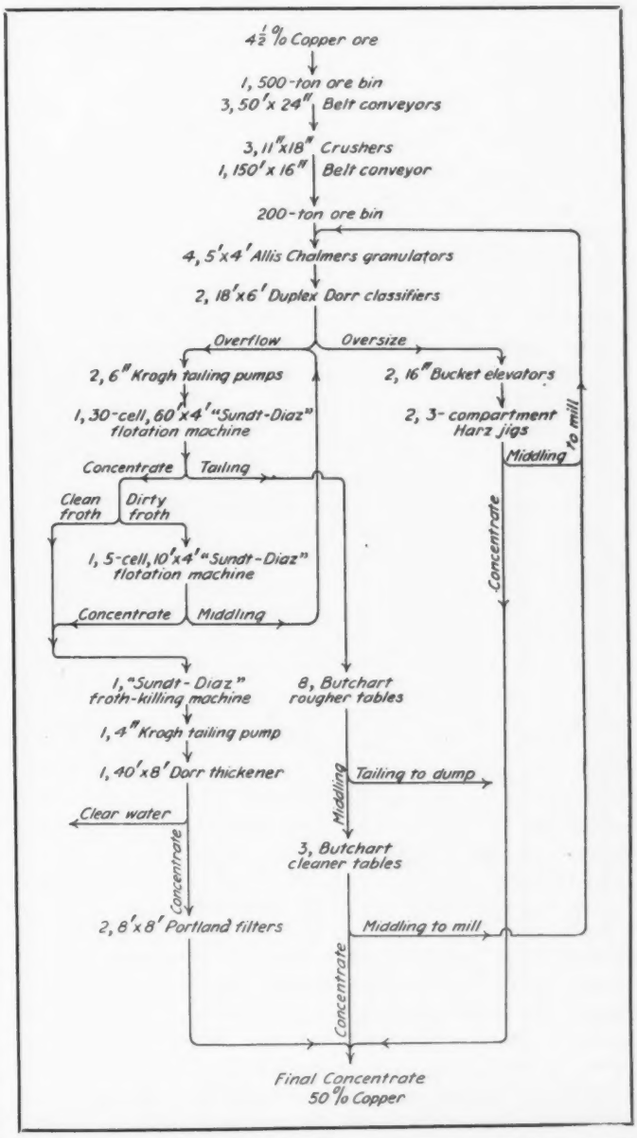
Ores Containing Chalcocite and Native Copper Treated by Jigs, Tables, and Flotation

By F. A. Sundt
General Manager, Cia. Corocoro de Bolivia

NATIVE COPPER is now being mined and concentrated on an increasing scale at the property of the Compañía Corocoro de Bolivia. From 1918 to 1923 the ore was almost entirely chalcocite, but during 1923 a considerable amount of native copper was also present, and in the future it is proposed to treat native copper ores exclusively. A large tonnage is available, averaging about 2 per cent copper, and the concentrator will be enlarged from a daily capacity of 400 tons to 1,000. One of the mines has a depth of 400 meters, with the native copper present in veins 2 meters wide; the other mines are only 180 meters deep, but all will average 2 per cent native copper or better. The gangue is siliceous. The ore is very soft. Each of the 5x4-in. Allis-Chalmers granulators can grind 250 tons a day from 3 in. to 100 mesh. The total power used in the plant to treat 400 tons daily is only 180 hp., and as the mill is erected on a level site, much of this power goes for the pumps and elevators. The blowers which furnish the 5-lb. air for flotation use only 35 hp. The flotation machines used were described in *Mining Journal-Press* of Sept. 30, 1922, p. 586. Only about 0.2 lb. of steel balls are used in the granulators per ton of ore ground.

F. A. Sundt

The concentrates from the jigs are 60 per cent through 65 mesh. The jigs operate at 250 strokes per minute, the length of stroke being from ½ to ¾ in. Most of the copper lost in the tailings is in an oxidized or semi-oxidized condition.



Flow sheet of the 400-ton Corocoro concentrating plant

The First Use of Metals

I—Gold and Silver

By T. A. Rickard

IT IS PROBABLE that the first metal to attract the attention of man was gold, because it is one of the few metals found in its elemental condition in nature, and of those thus found in the native state it is the most beautiful. Therefore it would appeal to primitive man, as to a child. Moreover, unlike other metals, it does not tarnish on exposure to the air; it does not oxidize, but remains bright and pretty. The savage would see it in the river gravel, he would discover that it was soft, and therefore easily hammered into shape, so he would make it into an ornament. Gold is widely distributed in nature; it has been mined in every region where the rock surface is not covered with moss, jungle, or drifting sand. In every country of antiquity it has been mined, even in modern days; it has been obtained in each of the British principalities, and in Wales and Ireland recently; in most of the states of the American Union it has been exploited profitably, in Maine and Vermont as well as in Georgia and California. Even in the rocks of localities far from known gold-bearing veins or lodes, it has been detected by assay. Gold is almost as widely distributed as iron, with which, in some form, it usually is associated.

Alluvial Gold Does Not Imply Presence of Lodes or Veins

Owing to its comparative insolubility and its resistance to oxidation, gold is relatively imperishable, so that even a minute proportion of the metal in the rocks will, in process of time, by erosion of the incasing rock and by subsequent concentration, form an accumulation of economic value. In many districts in which alluvial gold has been mined successfully, the modern prospector has failed to find veins or lodes worthy of exploitation. This is not surprising. Insignificant veins, containing only traces of gold, may, in the course of ages, by weathering and erosion, yield concentrations worthy of recovery. When, in any given region, the inhabitants started to collect the gold, they, if they were the first to do so, had the benefit of natural processes that had been at work for thousands of years. As the rocks in every region contained at least a little gold, so in every region there was to be found in the gravel of the rivers, which are the sluice boxes of nature, enough gold to constitute a treasure. That is why in some districts today the aborigines are found in possession of gold, usually in the form of rings and bracelets, sufficient to excite the imagination of the modern miner, although usually the sources of the gold cannot be traced now even by the most experienced of prospectors.

Another phase of this subject of the wide dispersion of gold presents itself when we remember that gold is relatively soft, and therefore is easily abraded in course of being rolled or washed down the hillside into the stream, which carries the particles of metal, as dust or flakes, into the sea, to become the sport of the tides. There ultimately the gold becomes dissolved, for the waters of the ocean contain an appreciable proportion of gold, as Sondstadt proved in 1872. Since then Liversidge has determined the proportion as between 0.5 and 1.0 grain per ton of sea water, or, averaging, about 200 tons of gold per cubic mile of ocean. As there are 400 million cubic miles of ocean, the gold in it represents 80,000 million tons, as against the world's total production of only 5,020 tons in the four centuries from 1492 (the discovery of America) to 1892. The gold is carried with the sea water into the sediment deposited on the floor of the ocean, and, in due course, as the sediment is consolidated into rock, the gold-bearing solution is impelled by pressure and heat to circulate upward along the fractures made in the overlying rocks by crustal unrest, whereupon eventually the gold becomes precipitated with other minerals in the form of ore, and on thus completing its cycle of change it is ready to start on a fresh migration, as a part of the eternal movement by which the balance of nature is maintained.

Gold being so widely distributed, it is not surprising that bits of it are found among the relics of early man in countries far apart. It appears among the ornaments of jet and amber worn by pre-historic people. In Ireland the Neolithic remains are notably rich in gold; so are the Minoan relics of Crete. Beads made of gold have been found in Neolithic monuments in France. The pre-dynastic remains of Egypt contain many examples of jewelry made of gold. Its bright lustre and the permanency of its color gave it a high value, and its softness or malleability enabled primitive man to hammer it into the shape he desired, even when his tools were made of rough stone. At the time when Brazil was discovered by the Portuguese, only four hundred years ago, the natives were making their fishhooks out of gold, and today some of the natives of Colombia continue to do so.

Gold was the first metal to attract man, and the first gold mine was a placer—that is, a deposit of sand or gravel, usually on the edge of a stream. Long before man possessed either the knowledge or the tools required to dig into the hard ore of a vein or lode, he could—as a child could—pick bits of the shining metal out of the gravel. First the lumps, or nuggets, would catch his eye. The biggest nugget ever found weighed 190 lb.; it was uncovered near Ballarat, in Australia, in 1869. From the mere gathering of the gold exposed to view the savage would proceed to hunt for the smaller particles by sifting the sand, using water to aid him in the operation. Thus he devised a way of washing, which essentially is a method of concentration, like that of nature. As gold is the heaviest of the common metals, it is the easiest to concentrate; therefore gold washing is the simplest form of mining.

The next metal to be found by man would be copper, which also occurs native, and in that state bears some resemblance to gold; its color and softness would attract early attention among a primitive people that had learned already to appreciate gold. Copper also is a metal that is widely distributed over the face of the earth, although not as widely as gold, so that deposits of copper are found in most countries, including those in which the earliest civilizations had their rise. Metallic copper exists in leaf shape in some ores and in lumps in others. The finding of copper in this form is not

rare today, and it must have been common in the days before the most accessible outcrops, or surficial showings of ore, had been mined. Masses of this metal are found in the beds of rivers that traverse regions rich in copper, such as the Copper and White rivers, in Alaska.

Indians Found Uses For Native Copper

It is probable that primitive man detected nodules of copper when searching for nuggets of gold; he would treat them alike, that is, as soft stone; he would hammer the metal for service as an ornament first, and then, when it became more plentiful, as a weapon or implement. The North American Indians found metallic copper in the outcrops of the Lake Superior region, and hammered it into shape; likewise the Indians of New Mexico obtained a supply of copper, in leaf form, in the Santa Rita district, and used it in the same lithic way long before they learned to melt it into castings of desired form. Today the Eskimos living on the Arctic shore of Coronation Gulf go to the Coppermine River to obtain native copper, which they hammer into weapons and implements, such as arrow-heads, spear-heads, and knives. Occasionally they find pieces large enough to beat into knives eight inches long and three inches wide. They possess no proper tools for mining, and therefore are restricted to grubbing for pieces of metal that have been set free by the weathering and decomposition of the incasing rock. That is how primitive man, thousands of years ago, obtained his copper.

In the ancient copper mines of the Lake Superior region, the proof of pre-historic operations is given by large numbers of hammers that consist merely of water-worn oblong boulders of greenstone, chipped roughly in the centre, so as to permit of their being hafted by aid of withes. These rough hammers weigh from ten to forty pounds apiece; they are similar to the mauls found in the ancient copper mines of Wales and Spain. Pieces of native copper have been found in the Palæolithic tumuli of the Mississippi Valley. A mass of copper weighing three tons was discovered in an abandoned working on Isle Royale, off the coast of Michigan; the working was 16½ ft. deep and the metal bore the marks of stone hammers. Evidence exists for believing that the Indians built fires around these masses and thereby loosened the adhering rock, after which they pounded the copper into waves, until it broke apart in fragments. One celebrated boulder of copper reported repeatedly by the early voyageurs on the Ontonagon River is now in the Smithsonian Institution at Washington. It weighs 6,500 lb. Close to it were found many stone hammers. The largest mass of native copper ever known was mined in the Minnesota mine, in the Ontonagon district of the Lake Superior region, in 1880. It weighed 420 tons; the chips made in cutting it previous to removal weighed 27 tons, and the sale of them sufficed to meet the total cost of extricating the entire mass.

When the European first came to the northern parts of the American continent he found the Indians in a state of stone culture; they had not learned how to melt metals, and therefore shaped them by hammering. In 1610 an Algonquin chief, on meeting De Champlain, the founder of Quebec, gave him a piece of copper a foot long that had been hammered with stone. It is true he records that the chief led him to understand that the copper came from the edge of a stream near a great lake and that the Indians took it piecemeal and melted it into strips, which they made into one by hammering; but, as stated already, the copper did not show signs of casting, nor have any pieces of melted copper been found among the ancient implements buried in that part of North America. It has been remarked repeatedly by archæologists that the altar fires of the Indians were hot enough to melt the copper ornaments that were placed upon them and therefore that it is strange they failed to discover the fusibility of copper, but this inference is without metallurgical confirmation, for copper melts at 1,083 deg. C., whereas the slow burning of wood on an altar, without any forced draft, would yield a temperature of not more than 500 deg. The use of fire to loosen the rock adhering to the masses of copper in the Lake Superior region might, one would surmise, lead the Indians to discover that the copper could be melted, but, again, the wood fires used for the purpose probably did not generate heat sufficient to fuse the metal. On the contrary, the evidence available compels us to conclude that primitive man everywhere began by hammering the native copper that he found, and that a long time passed before he melted it into shape by the process known as casting.

Silver Rare in Neolithic Relics

Silver is rare among Neolithic relics, but it was known in Egypt at an early period. Like gold and copper, it occurs in the native state, in wire form and in leaf-like shape. It would be found in the outcrops of veins, but it might not be recognized at first, because it tarnishes quickly, although it was not blackened as rapidly in primeval times, when the air was pure, as in our own day when silverware is attacked readily by the sulphurous fume from coal fires. Primitive man would hammer the silver into ornaments, having ascertained not only that it was soft but that it was brightened by hammering. Pure silver is associated with the native copper of the Lake Superior ore; the largest lumps, weighing 25 to 30 lb., having been unearthed in the Cliff mine. Masses of metallic silver have been found elsewhere, as in the Smuggler mine, at Aspen, in Colorado, in 1894. The largest single piece brought to the surface weighed 1,842 lb. In the Kongsberg mines, in Norway, many such lumps have been found, the largest of them weighing 1,537 lb. In the Nipissing mine, at Cobalt, Ontario, a vein, 5 ft. wide, of nearly pure silver was exposed when the moss had been stripped off the rocky surface in 1906; and later 3,000 lb. of solid silver was taken out of the shallow workings. At Hien De La Encina, in Spain, a mass of silver weighing eight tons is said to have been mined in 1860.

Ancient Theories With Regard to Ores and Metals

Lucretius, and other classical poets, credit the discovery of metals to a conflagration in a forest, producing heat sufficient to fuse the metals—to sweat them, as it were, out of the rocks. The idea is not so extravagant as at first sight it may appear. Diodorus Siculus records the finding of silver on the Iberian peninsula, now known as Spain, by shepherds who set fire to a forest in the Pyrenees and thus produced heat enough to melt the silver in the veins. This Greek historian of the first century before our era asserts that the metal "flowed in streams of pure silver." The action of the shepherds in employing incendiarism to clear the forest and make room for the grass to grow for their flocks reminds one of the practice of the Western American

prospector, who, until the Forest Service stood on guard to check him, would start a forest fire in order to burn the underbrush, and so expose the rocky surface to inspection. In 1630 an Indian shepherd on the Cerro de Pasco lit a camp fire on the mountain side and found next morning that he had melted silver out of the rock underneath the ashes. That marked the outcrop of a vein famous in Peruvian history, but today associated with an important copper-mining enterprise. The association of copper with silver in an ore deposit suggests also that the finding of one metal might lead to the finding of the other; for example, the discovery of native silver in an ore and the attempt to smelt it by a primitive method might lead to the production of a silver-copper alloy. To a similar association of metals in ores is due probably the first making of bronze and of brass.

To be continued

Madagascar's Graphite Industry

INDUSTRIAL graphite in Madagascar is found (1) in gneiss and mica schist formations, in which it appears to take the place of mica, which it partly replaces; and (2) in laterite formed by the decomposition of these rocks, according to Elwood A. Welden, in *Commerce Reports*. In the close vicinity of the outcrops and parallel to them occurs a considerable quantity of white quartz which seems to bear a direct relation to the formation of the graphite. In general, the formation is very irregular and appears as a mass in lenticular form. A striking peculiarity of these masses is the abruptness with which they appear and disappear in the rock formations. The graphite-bearing gneiss is of medium-sized grains, containing crystals of hornblende and becoming less rich in mica as the graphite increases. This decrease in mica content in direct proportion to the increase of graphite content is of great industrial interest.

The main characteristic of the deposits lies in the absolute change of the native rock everywhere observed in the neighborhood of outcrops. The gneiss is transformed into a brownish substance with white or yellow grains, proceeding from the decomposition of the crystals. This is one of the reasons for the industrial value of the deposits, since mechanical treatment can be carried out under economical conditions.

Deposits Average 80 Per Cent

The graphite found in Madagascar is of the flake type, and the crystals are of varying dimensions, having a diameter of from one to three millimeters and occasionally of one centimeter. Some deposits contain the mineral in the form of prismatic needles, but occurrences of the amorphous type are rare. On the central plateau it is not uncommon to find deposits containing all three kinds of graphite, but the flake type is usually the most plentiful, giving a schistlike appearance to the graphite, which occurs in a more or less thick band of small veins separated by quartz fragments identical with the sand found on the seacoast. The average content of graphite in the deposits is as high as 80 per cent, but the yield on the central plateau rarely exceeds 7 per cent, or 7 tons of graphite for every 100 tons of rock extracted. Madagascar graphite shows a high carbon content and may be used in the manufacture of products resisting ordinary processes of reduction, such as crucibles. Varieties which contain little mica and no quartz are used for the manufacture of lubricants and paints, but their value is less than that of the quality used for crucibles. The finest type, containing from 97 to 98 per cent of carbon, may be taken by manufacturers of electrical apparatus.

The system adopted for the removal of the graphite from the deposits is in general that of open workings by levels. The superficial matter covering the mineral is removed, levels are made from two and one-half to three meters in height, and the mineral is taken out with spades. In view of the large number of known outcrops, this method should furnish the colony with a sufficient output for many years and render underground operations unnecessary. Graphite concentration is carried out in a simple and economical manner. A primary concentration is made by washing in a trough or mixer in order to separate the graphite from surrounding impurities. It is then dried in the sun or in rotary driers, concentrated mechanically in shaker screens, classified by weight, and separated from the quartz grains by air or oil. This treatment recovers from 50 to 75 per cent of the mineral, and the graphite thus obtained is used for crucibles. Some mine owners in Madagascar are considering a still higher concentration by means of mechanical processes which will give a much greater yield of the product, but the various chemical methods in use elsewhere are not adaptable to deposits in the colony.

Since the war the graphite industry of Madagascar has suffered from the general disorganization of commerce and industry. There has been a noteworthy decrease in the manufacture of crucibles, and as a result the production of crystalline graphite has been reduced. Moreover, the heavy stocks on hand in European countries have served to meet the demands of the past few years. The following table shows the production and export of graphite of Madagascar since 1913:

Years	Production Metric Tons	Exports Metric Tons	Years	Production Metric Tons	Exports Metric Tons
1913.....	7,997	6,310	1918.....	16,000	14,622
1914.....	11,232	7,749	1919.....	5,000	4,983
1915.....	15,940	11,851	1920.....	4,000	14,423
1916.....	26,524	25,480	1921.....	6,000	6,220
1917.....	35,000	26,943	1922, first 9 months..	6,676	5,273

By a decree of the governor general dated March 15, 1922, an official graphite commission was created, presided over by an engineer of the mining office and consisting of mine owners of the colony. This commission examines all technical and economic questions relating to graphite production and initiates steps for the development of the industry. In order to prevent the sale of graphite from other countries as Madagascar graphite, steps were taken to standardize the type of production. The standard as determined provides for a maximum ash content of 13.5 per cent, a sieve residue minimum of 98 per cent, and a clean appearance. If the graphite mined meets the requirements of the standard type, the receiver of customs attaches to each sack a seal marked "Graphite Standard Madagascar 1," thus giving a complete guaranty.

The mining tax on graphite since December, 1922, has been 5 francs, based on a valuation of 200 francs per metric ton.

USEFUL OPERATING IDEAS

Loading Device for Slushing

By I. W. Farrand

DRIFT MUCKING is one of the most important phases of underground operations at the Cerro de Pasco mines. Mucking at the face of the drift is one of the important factors controlling both speed and cost. The various loading machines as at present designed entail a high initial expense, and maintenance charges are in many instances so high as to make the cost of mucking equal to or in excess of hand handling. However, speed is the redeeming feature. Under certain conditions the scraper cannot compete with mechanical loading machines. A cheap and easily moved scraper dump overcomes the high initial cost and high repair charges and makes possible a marked increase in loading speed over hand work.

For some time I have been experimenting on a scraper for use in tunnel work. A device has been developed which has given satisfactory results in our drifts and tunnels. It consists of a four-wheeled steel-frame truck as shown in Fig. 1. This is equipped with two vertical air cylinders, each operated by a four-way valve. The cylinders are 6 in. in diameter and will lift 700 lb. 20 in. with 70-lb. air pressure. Each piston is provided with a 7x10-in. lifting head. Two wooden frames are placed on either end and are of sufficient width to carry the loading pan when the air pistons are down. The loading pan is of steel and is 10 ft. long. At one end a double-drum hoist is fastened and at the other a slide is attached by hooks as shown in Fig. 2. A loading hole 2x3 ft. is cut in the pan. The slide is slotted to fit down over the tracks, which are 30-lb. rails, 20-in. gage. Two 4-in. bars are attached to the ends of the pan. Both ends of the bars are equipped with screw jacks, the length of the screw being 18 in. The loading rig is carried on the truck. The scraper used is patterned after the Joplin type, shown in *Engineering and Mining Journal* of Dec. 17, 1921, in an article by Ward Royce. A 6-in. saw-tooth edge is used and two rail teeth are fastened on each side.

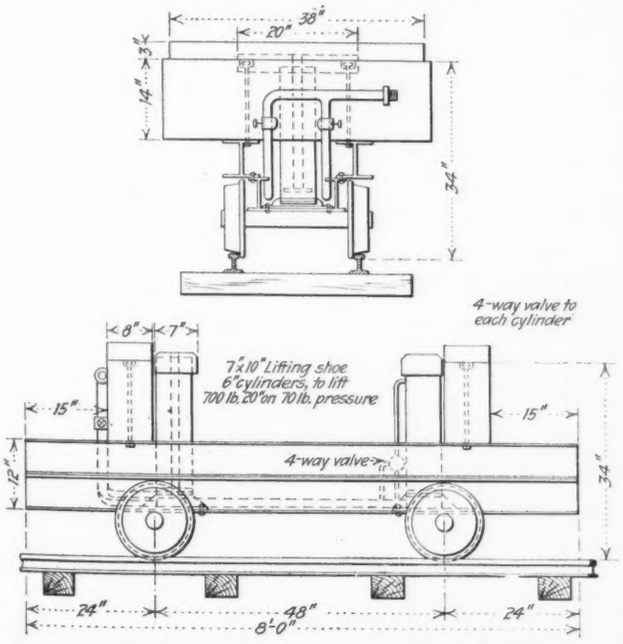


Fig. 1—Truck for transporting scraper platform used by Cerro de Pasco Copper Corporation

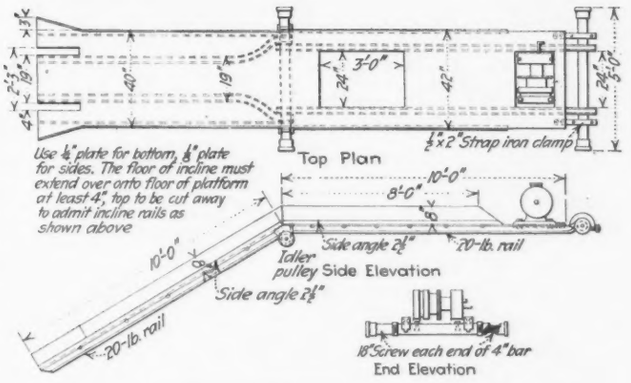
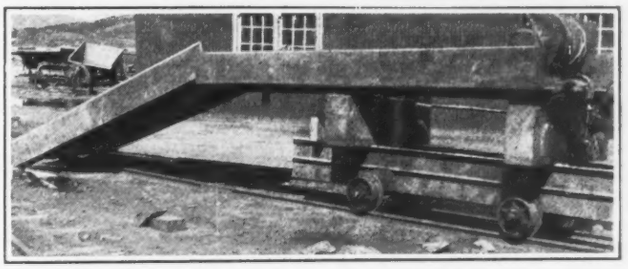


Fig. 2—Incline platform for slushing in drifts

The arrangement will work efficiently in a drift of minimum cross-section 5x6 ft. The height of car is the limiting factor. The average size of drift in our present workings is 6x7.5 ft. This is used for motor haulage. The facility with which cars can be brought to the face influences the rapidity of cleaning out the drift. The average time to load 27-cu.ft. cars, not including tramming, is four minutes. The average time to set up the arrangement ready for work is thirty minutes. This time is being gradually decreased. The time required to set up both bars is usually about the same as is required for setting one machine bar in place. This is a result of being able to roll the carrying truck directly under the position of set-up and also because the whole outfit is raised by means of air cylinders and held while blocking and tightening screws. Three men are used to operate the device, one at the double-drum hoist and two at the scraper end. After a short ex-



Loading pan and slide before carrying truck is removed

Useful Operating Ideas

perience three men clean two headings in an eight-hour shift. When long distances are to be traversed, a motor is used to transport the equipment, and the men ride to the loading point. The miners at the face are not

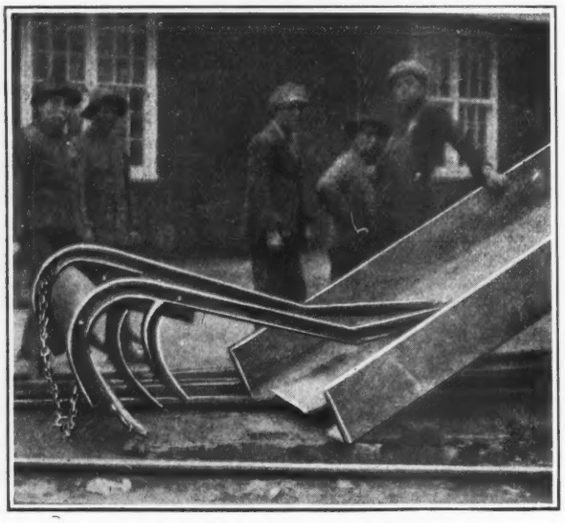
Hoist end of loading pan

hindered, as the scraper loader is operated independently of them.

In my opinion, where possible, two headings should be worked by the same crew of miners. Under these conditions the loading crews could clean four separate headings once in twenty-four hours, instead of two headings twice in twenty-four hours. My observations lead me to estimate that one crew can clean out three faces in eight hours where the distances between the headings are short. The operating instructions are as follows:

1. The track is cleaned of scattered rock by mucking it up toward the face and clearing a position for a handy set-up, the closer to the pile the better.

2. The truck, carrying the platform, is run up to within ten feet of where track cleaning stopped, or to the good set-up position.



Scraper at foot of slide

3. The slide action of the platform is pulled off the truck until the hooks drop over the front bar and the slots at the lower end drop over the rails.

4. The hoist end is raised by the air cylinders to a sufficient height to clear the muck car and the bar is then blocked and tightened.

5. The front bar is raised and blocked and screwed tight.

6. The carrying truck is then switched back out of the way.

7. The snatch block is carried to the face, with tail cable running loose, and fastened into a hole in the end of a piece of short steel which has been inserted and wedged in a shallow drill hole in the roof. This has been found to be the most satisfactory fastening for the snatch block at the face. The hole is drilled into the back as close to the face as possible before blasting the round. The scraper is then ready to operate.

It has been the practice to give a bonus to each crew satisfactorily cleaning up two 5-ft. rounds in a 6x7.5-ft. drift, or the equivalent in a shift. Over this amount the bonus increases proportionately.

To facilitate the rapid handling of cars to the scraper platform, a modification of the slick sheet is used. A long slick sheet is arranged with a drop tongue on each

Fig. 3—Modified slick sheet used to facilitate handling of cars at scraper platform

end, which serves as an incline for the flange of the car wheel. The drop tongue is made slightly smaller in width than the gage of the track and placed as near to one side of the sheet as practicable, about two or three inches (Fig. 3). The loaded cars coming from the loading platform pass directly up and over the slick sheet, but the empty cars coming up to the face pass onto the sheet and are moved over to one side and allowed to remain there until needed at the loading platform. The temporary switching platform is kept as near the loading platform as the heading will permit, so that a minimum loss of time for changing cars will result.

The size and thickness of the turn sheet depend on the size of the cars used. The dimensions of the heading will also restrict the placing of the sheet. It is sometimes found necessary to throw the track out of alignment temporarily to get the clearance on the opposite side for the empty cars.

DISCUSSION

"Engineering and Mining Journal-Press" is not responsible for statements or opinions published under "Discussion." In many cases the views expressed are diametrically opposed to editorial policy and belief.

The McGregor Bill

THE EDITOR:

Sir—An ingenious currency scheme, for free and unlimited monetization (but not coinage) of silver, and under a gold standard, is the bill of Congressman McGregor of New York (H.R. 88, 68th Congress, First Session). Who may be the author of this "request" bill I do not know, nor does it matter.

Under the provisions of this bill any one may tender any silver bullion to the Treasury. He will receive for it Treasury silver notes in amount equal to the market value of the silver, whatever may be the market value (but not over $1.50 per fine ounce). The notes are redeemable in bullion mint bars—at market prices. The Secretary of the Treasury posts each day the official silver market price, as he ascertains it from world markets. The next day silver notes are issued for, and redeemed in, silver bullion at that price. In short, a $10 note is issued on deposit of $10 worth of silver, whatever amount of silver that may be; and it is redeemed in $10 worth of silver, whatever amount *that* may be. The note would be full and complete legal tender, for *all* debts, public and private.[1]

There appears not a chance of enactment of such a bill in this day and generation in this country, however much modified; yet the same scheme, "amended," was once our law, the Act of July 14, 1890: "An Act Authorizing the Issue of Treasury Notes for Deposits of Silver Bullion," and some of those Treasury notes still circulate!

The 1890 plan was the work of Secretary of the Treasury Windom and the Harrison administration. The Fifty-first Congress that convened in December, 1889, was rabidly free-silver in the Senate, mildly so in the House. The administration hoped to stall off "free-silver" coinage at 16-to-1 fixed ratio; also, the compulsory purchase and coinage of $2,000,000 every month, in silver dollars, for nearly twelve years past, under the Bland-Allison Act of 1878, if continued in perpetuity would avowedly undermine the gold standard. The administration introduced its own bill for free silver by the Windom plan as H.R. bill 5381 on Jan. 20, 1890, and an identical Senate bill, 2350, on Jan. 28. The bill sought to repeal the compulsory purchase and coinage of the 1878 Bland-Allison Act, and restrain further coinage of silver dollars.

Any one might tender unlimited amounts of silver to the Treasury (but not at over $1.2929 per ounce, $1 for 371¼ grains). The Treasury would pay the market price; pay in Treasury notes created by the act; and the Treasury notes would be redeemable in silver bullion at market price—gold at government option, silver dollars at noteholder's option. The silver had to be the product of United States mines, smelters, *or* refineries. A "joker" permitted imported ores and base bullions. The notes are not full legal tender.

The Windom bill was passed by the House. Senator Jones, of Nevada, free-silver leader in the Senate, reported it out in "amended" form, passed by the Senate, but the House refused to concur, and demanded the original bill. A joint conference succeeded in forcing the "amended" Senate plan. The amendment consisted in the words *"strike out all"* (!) after the title, and gave us the well-known Sherman Silver-Purchase Act of July 14, 1890, with a different kind of Treasury note of 1890 from that contemplated in the Windom plan! The Sherman Law was followed Jan. 15 next by the Senate passing the outright Free-Silver bill of Senator Stewart, of Nevada, which the House killed, and in 1893 the Sherman Law was repealed.

When the late Andrew Carnegie, in those times a rabid goldbug and anti free-silver in any form (with or without international agreement) wrote his "A-B-C of Money," he recommended the Windom plan.

The first proposal in the United States for the Treasury to accept silver, at market value, and issue legal-tender notes thereon, was in the Warner bill, passed May 24, 1879, by the House, pigeon-holed in the Senate, and never resurrected. Section 8 authorized $5 and higher denominations of certificates to be issued for silver bullion at the market price of the week before. The next summer, a halt in further coinage of standard silver dollars of 412½ grains weight was urged at the American Bankers Association meeting at Saratoga Aug. 12, 1880. This was, among others, by George S. Coe, president of the American Exchange National Bank of New York (in opposition to the Warner bill on that point). Mr. Coe, however, urged that the "Treasury receive silver bullion and issue certificates of deposits, *without limit*, in denominations, for circulation, as nearly as possible at the market value." The rival Warner and Coe silver certificates of deposit would be redeemable on demand in the same quantity of silver originally deposited, regardless of market value at time of redemption.

However, the first and by far the best of the modern proposals of the general scheme was by E. A. Caswell, bullion broker of New York (also anti-free silver). In the *Engineering and Mining Journal*, Jan. 30, 1886, Mr. Caswell proposed a Treasury note, to be full and complete legal tender, to be issued for silver bullion at the market value, and redeemable in bullion at the market price. However, he would strictly limit such notes, not only to small denominations, $1 to $50, but also limited in amount strictly to the needs of the country, as com-

[1]Our existing U. S. Treasury silver certificate is not lawful money among people and between banks. It is a legal tender in all payments to the government, and when so received "it may be reissued," but no law requires any person or bank to accept it. The clearing-house associations refused them in the early 80's. A law was then passed, not making them legal, but forbidding any national bank to belong to any clearing-house association that refuses silver certificates in "clearings." Banks may reckon the silver certificates in their legal reserves.

petently estimated, for proper volume of circulating medium, under a gold standard. That was a crying need in those days. Although small-denomination silver certificates followed shortly after in 1886, and constituted our $1 and $2 paper money almost exclusively up to February, 1917, this resulted perhaps not so much from Mr. Caswell's proposal, but probably more from certain proposals at the 1881 Paris Monetary Conference.

Mr. Caswell's plan was followed a few days later by the proposal by Lord Grey, in the London *Times*, for the issue of a properly *limited* amount of £1 notes; £5 was the lowest denomination Bank of England note issued since 1826. The new £1 notes would be issued for silver bullion, and redeemed in silver bullion, at market price of bullion. They would replace gold sovereigns out of circulation, and put them into a needed mobilized reserve. Sections 2 and 3 of the Bank Charter Act of 1844 permit the Bank to issue its notes against silver bullion at the market value, and to hold silver bullion in its Issue Department metallic reserve up to one-fifth such metallic reserve. However, notes must be redeemed in "lawful coin" since the Act of 1819, and any proposal to obliterate the sacred gold sovereign out of circulation stood as much chance in pre-war England as the Caswell-Windom scheme over here to retire that fetish, the alleged "dollar of the daddies." Earl Grey was "goldbug."

From the India angle, the plan was formulated Jan. 11, 1893, by Sir Raymond West before the Herschell Indian Currency Commission. Sir Raymond hoped to keep the India mints open to free acceptance of sliver, yet fix the rupee on a stable gold-exchange basis. His "imperial rupee" would be a paper note, with established gold-par. It would be issued either against gold, or silver bullion might be tendered at market value. The government would redeem each rupee note in a rupee's worth of silver bullion at the market value, or at the government option in gold. As Lord Herschell's committee had practically decided in advance to close the government's mints, Sir Raymond's proposal came to naught.

The plan freely to monetize silver "at the market" by the formula of paper money issued against, and redeemable in, silver bullion at market price of bullion was not again broached till Mr. McGregor's bill thirty-one years later. Even the Wolcott Mission omitted direct reference to any such plan among its numerous proposals in 1897.

The monetization of silver bullion, "at market value," is better realizable through revamping other of the old-time formulas and combinations of formulas, if realizable at all. C. L. BREGER.

New York.

Roasting Copper Ores

THE EDITOR:

Sir—I read with interest the article by Henry S. Mackay in your issue of Dec. 8, 1923, describing the "Mackay Electrochemical Process for Copper Ores." I have done considerable experimental work along the same lines and the method of roasting suggested by Mr. Mackay is covered by my U. S. Patent No. 1,376,025 and Australian Patent No. 15,656/20. These patents cover the formation of soluble copper compounds by gradually increasing the temperature throughout the roast and also the decomposition of the ferrous sulphate, formed during roasting, by increasing the terminal temperature of the roast.

My early work on roasting led me to believe that satisfactory results could only be obtained in a straight line furnace of the Edwards type, and I was of the same opinion as Mr. Mackay regarding the multi-hearth furnace of the Wedge-Herreshoff-MacDougall type. However, the makers of the Herreshoff furnace were certain that successful roasting could be performed in their standard furnace, and to prove the point, placed a small ten-hearth furnace at my convenience for experimental work. I operated this furnace for several months and found no difficulty in controlling the temperature on the various hearths, and the dropping of the ore from hearth to hearth proved to be advantageous, as much work being done in the drop through the hot gases as on the hearth itself. This latter point has the effect of reducing the time of roasting and increasing the capacity of the furnace. Some particulars of experiments conducted in this small Herreshoff furnace were published in this journal ("Sulphatizing Roasting of Semi-Oxidized Copper Ores," April 15, 1922).

I am now of the opinion that successful roasting for subsequent leaching can be accomplished in any standard type of furnace without the modifications suggested by Mr. Mackay. PERCY R. MIDDLETON.

Melbourne, Australia.

Electrothermic Zinc Reduction

THE EDITOR:

Sir—There is one phase of electrothermic zinc reduction discussed by Prof. Charles H. Fulton and others in your journal and elsewhere that in the light of my own experience, covering now nearly twenty-one years, needs both comment and correction. I refer to Prof. Fulton's statement in regard to the supposed action of the carbon monoxide of the condenser gases in effecting a supposed reduction of the iron oxides and silicates of the firebrick with the subsequent swelling and disintegration of the brick and with the final failure of the condenser.

In the first place, it is clear that as the zinc in the proportion of the gases emanating from the furnace and at the temperature of condensation is more sensitive to carbon dioxide than carbon monoxide is to oxygen at the same chemical pressure and especially as zinc is a monatomic vapor (and hence much more penetrating), the reduction of iron oxide, such as may take place, comes primarily from this higher and stronger reducing agent. This is quite plain from the theory of chemical equilibria worked out by Prof. Boedlander (*Zeitschrift für Electrochemie*, Vol. 8, pp. 833 et seq.). My experience shows that such a theory is entirely correct.

Next, there can be and usually is a deterioration in the walls of a condenser designed and built by those new to the difficult art of electric zinc smelting. For when the action is intermittent instead of continuous, it occurs not infrequently with disastrous effects when a number of runs are made; but it is the zinc metal that causes the trouble and not "the carbon deposition." Quite naturally the molten zinc expands and contracts during the intermittent heating and cooling and also a number of zinc compounds such as zinc aluminate—the so-called zinc spinel—the ferrite, ferrate, silicate, etc., are formed, and the pores and porules of the

brick are the seat of a tremendous force, if the action be repeated several times.

When conditions are untoward and a condenser poorly designed has run some ten or a dozen runs, this force shows itself spectacularly. I vividly recall giving a quick shift of the stomach to avoid a ¾-in. tie-rod that snapped at the weld and seemed fated for my solar plexus. I also recall that in 1904 this force bent some 50-lb. rails about 4.5 in. in 6 ft. on our electric furnace No. 6. It seems that this force is similar to that mentioned in the *Journal-Press* about six months ago and shown in the reproduction of a photograph of a copper furnace converted to a lead furnace, in its columns. The phenomenon resembles that which the colloidal chemists call "adsorption." In 1904, James McKnight, then manager of Harbison-Walker Co., and I got our heads together and made up several thousand of a firebrick containing about 5 per cent lime and (or) iron blast furnace slag, which brick were vitrified at 1,400 deg. C. This made practically a high melting point firebrick. I became tired of paying the high price for these and later came to the practice of using a hard-burned firebrick doped with a solution of water-glass and after that with a calcium chloride solution. This formed a lime silicate and sodium chloride in the pores and porules, so making a dense-body brick cheaply. No adsorption took place and with continuous working for forty-one days the condenser stood up very well.

There is the further point that firebrick is not a good conductor of heat. Accordingly the amount of heat to be abstracted from a condenser of large size is not inconsiderable. The sensible heat of the gases from 1,000 to 500 deg. C. is quite an amount, and then we have the 410 kg.cal (this is my figure—the late J. W. Richards gives 425) of the latent heat of evaporation in addition. Prof. Fulton does not make provision for removing this heat under control and in his published design shows no effectual means for regulating the temperature of the condenser at the will of the furnace man. Since my old patents on this are about to expire and show a workable arrangement for removing this heat and also for adding heat, should the furnace work "off" and not supply enough heat to balance the radiation, it is surprising to me that he did not avail himself of this means, which every one of the seventy-five or eighty engineers who visited my plant knew about. For this purpose, the lining of the condenser should be a refractory with as high a conductivity as is possible. For this purpose, then, we found that magnesite brick—the ordinary kind used in the open-hearth steel furnace—were as good as any. This was doped with the same solution as the firebrick and made the best condenser I ever built. The only "out" to it is the expense of the magnesite brick. It is curious that these brick should stand up well if iron was fatal, as Prof. Fulton claims, because these magnesite brick analyzed some 6.4 per cent FeO. We may conclude that, broadly speaking, for the art of electric zinc smelting, he is wrong.

As a matter of fact, the design of the new unit which we hope to build shortly calls for a brick made of iron ore plus a small amount of plastic binder. This will have the advantages of both McKnight's brick and magnesite brick and will be far cheaper than either. With a proper control of expansion and with heat regulation, a condenser of these brick can be made to last indefinitely provided it is kept in *continuous operation*.

As to *intermittent operation*, which he recommends, it is both clear and conclusive that the life of the condenser due to the expansion and contraction on temperature changes and to the formation of zinc compounds with the loosely combined compounds of such brick as he must have had, would be short and at that not merry. With a dense brick and good conditions, it is a question how much shorter the life of the condenser would be than with continuous operation. Much would depend on the care and conscience of the furnacemen. My opinion is that they would get so disgusted with intermittent operation in electric zinc smelting that they would have no conscience left. I know that I saved myself morally as well as metallurgically by going over deliberately to continuous operations.

Under his own conditions, Prof. Fulton may be hypothetically correct, which I gravely doubt, but wide practice and sound theory appear to be on the other side. If a high-iron brick made one of the best condensers of the thirty-odd that I built, why is an "iron-free" brick discussed and recommended for large scale work?

The building and operating of a condenser has seven little "turns of the wrist" in it. In the entire art as I have developed it, I once counted up forty-six of these turns—most of them were chemical rather than mechanical.

WOOLSEY MCALPINE JOHNSON.

Argus, Pa.

A Square Deal for Prospector and Small Investor

THE EDITOR:

Sir—Last summer I was afoot on the road, and a man in a Lizzy stopped and invited me for a ride with him. He asked me where I lived and what I was doing. I told him, and then he told me part of his history. He said:

"Formerly I was living in a mining district in Pennsylvania, got married there, and I raised seven children. I always had a hankering for the West and would have liked to roam the glorious hills and prospect. I came west to Montana, but my family had to have bread and butter first, and roaming in the hills was out of the question. I am a mechanic, so I got a job in a shop and provided for the family. When the family was over the heaviest expense, my wife, who was of the same mind as myself, and I concluded that since we could not go into the hills ourselves, we would do the next best, we would buy shares in prospects; this was a frame of mind well prepared for the bunco man in the mining disguise, and they got in their deadly work all right. We never got any returns from any of our ventures. Not long ago we figured out what we ventured here and there, and it amounted to nearly $8,000, all out of the labor of myself and courageous wife. I have quit risking my money in ventures of this kind."

Here is a worthy honest man, willing to take a chance in the development of a mine, but instead of his earnings going to development of any venture, they are simply velvet to the crook with a silver tongue; school teachers, widows—all of these are prey to such crooks.

Cannot the lawmakers and mining engineers together find a way to protect these innocent but venturesome people from the buzzards?

W. H. B.

Montana.

THE MINING NEWS

The Mining News of ENGINEERING AND MINING JOURNAL-PRESS is obtained exclusively from its own staff and correspondents, both in the United States and in foreign fields. If, under exceptional conditions, material emanating from other sources is published, due acknowledgment and credit will be accorded.

Summary of the Week

THE Eagle-Picher Lead Co. has purchased the two mills and the mining properties of the Interstate Lead and Zinc Corporation at Crestline, Kan., for $600,000. Excessive water in the mines has prevented full production heretofore.

Earnings of the Tintic Standard Mining Co., operating at Eureka, Utah, are at the rate of $2,000,000 a year. Funds for a quarterly dividend are earned each month.

On April 1 the New Cornelia Copper Co. expects to start the fifth 1,000-ton unit of its new concentrator at Ajo. This is full capacity.

January output of gold from the Transvaal totals 796,768 oz., the second highest monthly production in the history of the Rand.

Investigation of the activities of the Bureau of Mines will be undertaken by the House Committee on Mines and Mining.

The organization of twelve new companies or syndicates in Seattle and Vancouver to operate in the Portland Canal district promises a busy season there.

Two important strikes 1,200 ft. below the present working level are reported by the Tamarack & Custer, in the Coeur d'Alene district.

The Chipman Chemical Engineering Co. wants custom arsenic ore for treatment at its plant at Martinez, Calif.

A long shoot of rich lead-silver ore has been opened, according to officials, in the Chloride Queen mine in Stevens County, Wash.

Shareholders in the Domes Mines Co. seek to oust J. S. Bache, New York broker, from control of company affairs.

The Mogollon Mines Co., in New Mexico, has started the Fanny cyanide plant recently leased from the American Silver Corporation.

Good Shoot of Silver-Lead Ore in Chloride Queen

Vein Said To Be 12 Ft. Wide, Averaging $15—Part Shipping Ore—Followed 100 Ft.

After drifting 800 ft. along a prominent fault fissure, a body of good ore 12 ft. wide has been opened up for 100 ft. in the Chloride Queen mine, 14 miles northeast of Colville in Stevens County, Wash.

The main tunnel had been cutting stringers of galena in its progress, but no large or persistent shoot of ore was encountered until a crosscut was started. In a few feet a fault carrying 18 in. of gouge was cut. Lying parallel to the fault a body of silver-lead ore has been exposed for 100 ft. with the same conditions still in the face and indications that it will continue. The fault fissure has been traced on the surface for several thousand feet.

Lying against the gouge of the fault is 5 ft. of high-grade ore, the rest of the vein being mill feed. The ore is galena carrying gray copper and some silver. Assays on the orebody range from $15 upward, according to the report of Rowland King, consulting engineer.

The ore was encountered 200 ft. below the surface, and a crosscut is being run to pick it up on a level 100 ft. below. Coupled with the strike made in the near-by Old Dominion mine, the Stevens County mining districts are showing signs of great activity. The showings on the Chloride Queen are regarded as the most favorable silver-lead deposits ever exposed in northeastern Washington.

Tintic Standard Earns Quarterly Dividend Each Month

THE Tintic Standard Mining Co., operating at Eureka, Utah, finds itself in a position to pay an extra dividend of 5c. a share on March 29, in addition to the 10c. payable each quarter, making a total disbursement of 15c. a share, or $169,445. The higher price of lead, together with production at shaft capacity, makes the larger payment possible. Since the beginning of the year the company has shipped 564 cars of ore. The treasury balance is reported at more than $2,000,000. Earnings are at the rate of over $2,000,000 a year, and the regular quarterly dividend, and more, is earned each month.

Mogollon Mines Co. Restarts Fanny Mill Under Lease

New Mexican Gold-Silver Camp Busy —Two Mills and Three Mines Active —Seventy-five More Men

After being idle since early in 1919, the Fanny mill and cyanide plant at Mogollon, N. M., is again in operation. Gold and silver ore up to 150 tons per day can be handled. The mill was put in actual operation on March 5, under a lease to the Mogollon Mines Co. by the American Silver Corporation, at present in a receivership.

The owners of the mill suffered a severe loss when the Fanny mill was destroyed by fire in 1917. It was rebuilt and began operating again in July, 1918, only to be closed down in March, 1919, and has been idle since that time.

The Mogollon Mines Co. is now operating at maximum capacity, operations including the Last Chance, Fanny, and Alberta mines, and the two mills. Reopening of the Fanny mill and power plant has added about seventy-five men to the payroll. Three shifts are at work in the mills, with two shifts in the mines. S. J. Kidder is general manager of the Mogollon Mines Co. and in this capacity has charge of all the work now in progress.

Dome Shareholders Condemn Bache's Control of Company

Want Separate New York Office—Promise of Reform Unheeded, Says Committee—Mine Management O.K.

A number of Canadian shareholders of the Dome Mines, Ltd., who are dissatisfied with the way in which the affairs of the company have been administered, have appointed a special committee to safeguard their interests in connection with the forthcoming annual meeting. The committee has issued a special circular to shareholders stating that in their opinion the board of directors is alone responsible for the disquieting conditions that exist. Satisfaction is expressed with the condition and management of the mine itself, but a protest is lodged against the degree of control exercised by the president, J. S. Bache, New York broker. The committee contends that the company should have its own independent office in New York and that the head office should control the company's operations as regards matters of policy.

It is asserted that the interests of the individual shareholders did not receive the careful attention to which they were entitled. "Without one word of explanation," the letter continues, "shareholders recently received a statement for the months of October, November, and December, which on the face of it indicated that the company had disposed of 46,666 shares of stock and that dividends had been paid on the stock." The net result of the transaction was that within a few days after the issue of the statement the market selling price of the shares depreciated by over $3 per share.

Concerning the assurance given at the last annual meeting that an effort would be made to adjust the complaints then lodged, it is pointed out that the situation still remains unchanged. "In the opinion of the committee," the letter concludes, "the basic reasons for the shareholders' dissatisfaction have not been removed, and it is time for an infusion of new blood in the company's directorate." The following signatures are attached: A. C. McMaster, Toronto; H. C. McCloskey, Cobalt; R. Horne Smith, Toronto; L. Erenhous, Haileybury; Richard Southam, Toronto; M. J. Wallace, North Bay; R. D. McLaren, Ottawa; Alfred L. K. Shillington, Ottawa; and W. M. Forrest, Toronto.

Utah Ore Shipments for Week Ended March 15

Eureka—Tintic Standard, 59 cars; Chief Consolidated, 32; Dragon, 8; Iron Blossom, 6; Bingham Mines, 5; Bullion Beck, 3; Centennial-Eureka, 2; Plutus, 1; Tintic Drain Tunnel, 1; Mammoth, 1; Godiva, 1; total, 119 cars.

Park City—Park-Utah, 2,031 tons; Park City Mining & Smelting, 1,152; Silver King Coalition, 889; Keystone, 230 tons; total, 4,302 tons.

Bingham—Utah Copper, 2,947 cars; Utah Consolidated, 152; United States, 46; Utah Apex, 12; Bingham Mines, 8; Ohio Copper, 2; total, 3,168 cars.

New Cornelia's Fifth 1,000-Ton Mill Unit in Operation April 1

ON MARCH 1, the third unit of the new concentrator of the New Cornelia Copper Co., at Ajo, Ariz., began operation, and the fourth unit was due to be started on March 18. The fifth and final unit will begin operating by April 1, it is planned. The new plant is operating efficiently, and extraction and tonnage expectations are being attained.

New Company Will Prospect Claims Near Bossburg, Wash.

A new corporation known as the Centennial Mines Co. has recently been organized in Spokane to take over the Minorca and Homestake groups of claims that are situated 8 miles northwest of Bossburg, Wash. The company has outlined a program of exploration of several veins which traverse the property. Copper, silver, and gold have been found, the vein resembling strongly the ores of the Leroi mines, at Rossland, a few miles north, in British Columbia.

Placer Operations Attract Attention at Oatman, Ariz.

Considerable interest is being evidenced in placer deposits in the Oatman gold district in Arizona. Many locations have been made on the gravel beds in various localities. The exploration work of the Gold Gulch Placers in the Silver Creek section is being watched with interest. A shaft is being sunk through the gravel to bedrock, which it is expected to reach at about 80 ft. Some water has been encountered at a depth of about 70 ft., which has delayed the work, but it has been found that better values occurred at the deepest part, and it is expected that higher values will be encountered at the bedrock.

Labor Union's Protest Ends German Immigration to Michigan Mines

As a result of protests made by labor unions at Sault Ste. Marie, Mich., a port of entry, to immigration and Department of Labor authorities, the permit of the mining companies of the Michigan copper district to import German workmen has been cancelled, according to advices received at Sault Ste. Marie.

Calumet & Hecla Consolidated was granted a permit to bring in 200 miners. Only 100 were admitted under this provision before it was cancelled, Department of Labor officials state. The Trades Council at Sault Ste. Marie, however, alleges that more than that number passed through and that many of them were not skilled miners, but tradesmen in various lines of occupation.

Operations Active in Nacozari District, Northern Sonora

Canario Copper Co. Develops—Moctezuma Short of Labor—El Tigre Mills 250 Tons per Day

Operations in the vicinity of Nacozari, in northern Sonora, Mexico, are active and have been little disturbed by the insurrection.

The Caridad mine, belonging to the Moctezuma Copper Co., is being worked under lease by Sam Clinch, who is shipping ore running 20 to 25 per cent copper and 8 to 10 oz. silver per ton.

At the Canario Copper Co.'s property, four miles northwest of Nacozari, extensive development work is being done. Operations are under the direction of John Carter Anderson, of Tucson. At the Rosales mine, 20 miles northeast of Nacozari, some good-grade copper-silver ore is being developed. The property is owned by Dr. Armstrong, of Douglas, Ariz.

The San Nicolas mine, 15 miles southwest of Chispas, has been unwatered. The property is owned by the Transvaal Copper Co. and is under lease to O. L. Neer and Leo G. Cloud. This property has produced about 4,000 oz. silver in the past few years and mining operations are to be resumed immediately.

The power house of the Las Chispas mine is nearing completion. One of the turbine generators has been installed and the second is nearly ready. The power plant is at Nacozari. The power line running to the mine, which is about 30 miles west of Nacozari, is nearly half completed.

There has been a shortage of skilled labor at the Moctezuma Copper Co.'s mine, but in the last few weeks more miners are returning and operations will soon be normal.

At San Jose, northeast of Nacozari, lessees are producing a few tons per day of 150-oz. silver ore.

Fifteen to twenty "gambasinas" are working the El Globe mine.

The Cinco de Mayo mine, in the El Tigre district, is being worked by a French syndicate which has the property under bond and lease. About 150 tons of ore per month running 150 oz. of silver is being produced and shipped.

The El Tigre mill is treating 250 tons of ore per day. This ore runs about 40 oz. silver per ton, 1 per cent lead, ¾ per cent copper, and 1 per cent zinc.

Mill Finished but No Power at Manhattan Consolidated

The 50-ton mill of the Manhattan Consolidated Mining Co. at Manhattan, Nev., is finished, and the main shaft has been retimbered to the 200 level. This completes preliminary work, and the company was all ready to start producing when an acute power shortage developed. For this reason it has been found necessary temporarily to lay off the crew.

The company claims to have a substantial tonnage of ore blocked out which will mill at least $15 per ton, and as both mining and milling costs should be low, profitable operations are anticipated.

Lessees Continue to Ship from Rochester Silver Mine

The Rochester Silver Corporation, whose Rochester property is being operated by lessees, shipped bullion in February valued at $26,105.53. Profits are not stated, but the grade of ore is said to be satisfactory with the present price received for silver. The best ore is being mined on the 800 level, in the northern part of the mine, where several shoots are opened.

Bonanza Mine to Install Forrester Rod Mill in New Plant

A Forrester balanced rod mill, being built by the Union Iron Works in Spokane, will be shipped soon to the Bonanza mine near Bossburg, Wash. The new mill will be used in connection with tables and flotation equipment to concentrate the ores. The mill is the invention of P. C. Forrester, of Tacoma, who is superintending the construction at the Union Iron Works.

Eagle-Picher Lead Co. Pays $600,000 for Interstate Mines Near Crestline, Kansas

THE Eagle-Picher Lead Co. has purchased the holdings of the Interstate Lead & Zinc Corporation, in the Crestline, Kan., field. The consideration is unofficially reported as being nearly $600,000, and a royalty interest retained for the former owners, J. W. Floyd, of Denver, and A. M. Gaines, of Joplin and Picher, Okla.

The property includes 538 acres of leases and two modern concentrating plants, known as the Ellis and Crutchfield. They were built in 1923 at a cost in excess of $150,000, and although completed some time ago, have not been able to produce regularly, on account of the heavy drainage problem involved in the deeper ground in the Crestline section. At the Ellis property the Interstate Corporation put down a 30-in. drill hole, the largest in this district, to make possible the installation of a 12-in. "Texas" pump, and since then another of similar size has been installed at the Crutchfield. Each has a capacity of 2,500 gal. per minute, but they have proved insufficient for the heavy flow of water.

The Eagle-Picher company has taken active charge of the properties and is preparing to install more pumps. Consummation of the sale was announced by A. E. Bendelari, of Joplin, agent for and vice-president of the Eagle-Picher company and A. M. Gaines, who is now acting as manager for the Kanok Metal Co.

North Butte Gets Power at Its Superior, Ariz., Property

The North Butte Mining Co. will soon have a power supply from the Roosevelt Dam at its new property near Superior, Ariz. Transmission lines are being constructed, and the installation of transformers and other equipment will soon be completed. This company is planning to prospect from the old shaft that was formerly operated by the Calumet & Arizona Mining Co., and exploration will be prosecuted by drifting and diamond drilling. Work on retimbering the old shaft is under way. This shaft was formerly operated to a depth of 750 ft. After completion of this work, efforts will be directed at prospecting. The formations are believed to be the same as those in which ore was found in the Magma property.

Utah Copper Wins Round in Tailing Tax Suit

The United States Supreme Court March 17 refused to grant a writ of certiorari sought by Salt Lake County, Utah, to review the decision of the lower courts in favor of the Utah Copper Co. in a suit to recover taxes, paid in 1917 and 1918 under protest, on partially reduced ores or tailing. The company alleged assessment of tailing was illegal. Though this action disposes of the writ of certiorari, there is pending an appeal in the same case by a writ of error, which will be argued some time next year.

Calumet-New Mexico Ships Rich Lead Ore to El Paso

The Calumet-New Mexico Mines Co., operating near Pinos Altos, N. M., last week shipped a carload of high-grade lead ore, carrying gold and silver values, which averaged $100 to the ton, to the smelter at El Paso.

The mine is situated between the Langston and the Silver Cell mines. The Langston mine has been famous for its pockets of gold, and the Silver Cell mine has the distinction of once having brought forth a silver nugget weighing 190 lb. At present the ore is being taken from a vein 8 to 10 in. wide about 30 ft. below the surface.

Construction Drags on Tamarack Reclamation Plant

Work is proceeding at the Tamarack reclamation plant of Calumet & Hecla Consolidated on the Tamarack conglomerate waste copper sands in Michigan. The project should be completed early in the summer, but it is doubtful whether the plant will be ready for operation by then. It will be a source of cheap copper, capable of producing at the rate of 800,000 lb. of refined metal per month, but the aim now is to curtail production rather than to enlarge it. Unless the metal market shows substantial improvement it is likely the plant will remain idle.

The dredge hull is being equipped and will be ready for use in the spring if needed. Machinery is being installed in the plant as received, but no effort is being made to speed up the work.

Colored Posters Assist Identification of Arsenical Ores

Chipman Chemical Engineering Co. Wants Ores for Martinez, Calif., Plant—Will Co-operate with Producers

Attractive colored posters printed in color with "lifelike" exactitude, showing samples of arsenic-bearing ores, are being distributed in the West by the Chipman Chemical Engineering Co. to assist the prospector or mine owner to identify ore containing minerals of this metal.

The company has recently started its arsenic plant at Martinez, Calif. This plant will add materially to the arsenic output of the country, producing refined white arsenic from the ores largely drawn from Nevada, though California, Arizona, Washington, and British Columbia mine operators are becoming interested. At Martinez are found the world's largest arsenic kitchens, and a complete assay department with a staff of engineers always on service. Mine operators, prospectors, and ore shippers are invited to forward arsenic-ore samples for assay free of charge. Prompt returns are made the shipper, and where satisfactory arsenic deposits are proved, the Martinez executives may co-operate in the development of the property. Several well paying silver, lead, and gold properties in California and Nevada have been brought to the shipping stage through these conditions.

To facilitate the mining man in marketing his arsenic ores, the company has placed in general circulation a blank questionnaire. The mine owner may fill in the answers to the technical questions propounded and then mail the form to the company's ore-purchasing agents with samples of ore. The Western Ore Purchasing Co. of Reno, Nev., will supply these questionnaires on request.

Colorado Fluorspar Producers Look for Prosperous Year

Scouts representing eastern brokers and consumers of fluorspar have been investigating ore supplies throughout Colorado, and producers are expecting a good demand during the remainder of 1924.

A marked change has taken place in conditions affecting the industries since the first of the year. The taking over of the Wagon Wheel Gap properties by the Colorado Fuel & Iron Co. has eliminated the C. F. & I. as a purchaser of spar, and in consequence independent producers are obliged to seek a market elsewhere.

During the last year a promising district has been opened up near Walden, in Jackson County, and is outputting about forty tons per day, the product going to a Chicago steel mill. It is believed that the district is able to maintain a much higher output of exceptionally high-grade material. The Boulder field is idle at present, but operations will begin early in April, it is reported, and continue regularly through the summer and autumn months at least.

Tamarack & Custer Has Cut Two Veins on Mammoth Level

Crosscut Opens Ore 1,200 Ft. Below Present Outlet—Mill Capacity to Be Increased

Two important strikes have recently been made by the Tamarack & Custer Consolidated Mining Co., of Wallace, Idaho, and another is expected when the Monroe vein is reached. These strikes were made through the extension of a crosscut from what is familiarly known as Mammoth tunnel No. 6. The crosscut was started more than a year ago, the purpose being to provide a new and permanent operating outlet for the mine on Canyon Creek, a short distance above the mill, at the same time developing the orebodies 1,200 ft. below No. 5 tunnel, the present outlet.

Tamarack has four veins, three of which have now been intersected and the fourth will soon be reached. The first one cut was the Custer, several months ago, which was without ore, as it was in the upper workings below No. 3 tunnel. The second was the Tamarack, in which a large body of ore was found corresponding in all respects to the showing above. The third was the North vein, in which more than 2 ft. of clean lead-silver ore was found and several feet of high-grade milling ore.

The fourth vein, called the Monroe, has the largest orebody in the upper workings. It is hoped that it will retain this relative position when reached on the new level. As a result of these developments, Tamarack now has a large increase in the tonnage available, and the company has made plans for adding to its milling capacity by the installation of new equipment.

The portal of the tunnel through which orebodies have been reached is less than a mile above the Tamarack mill on Canyon Creek, a situation that will greatly facilitate and reduce the cost of delivery of ore. Under the present system ore from the mine is delivered over a high divide by a rope tramway two miles long.

Increased Price Cut Hongkong Sales of Yunnan Tin

Hongkong trade in Yunnan tin made a poor showing in 1923, acording to a report from W. J. McCafferty, of the U. S. State Department. A satisfactory amount of business was done at the first of the year at about $90 Hongkong currency per picul, but the price advanced steadily to $102 in September and $120 in December, which curtailed transactions. Total exports for the year were about 8,600 tons, compared with 12,300 tons in 1922, the decline being most marked in the second half of the year.

The principal purchasing countries were the United States, which took 3,500 tons; Japan, 1,400 tons; and the United Kingdom, 400 tons. The bulk of the tin exported to the United States was shipped in January, April, and May; but the fourth largest month was December, when the price was highest. At the close of the year the price trend was still upward.

Smelter for Patagonia?

It is reported that work will be started on the erection of a small smelter at Patagonia, Ariz., in the next thirty days. The project is said to have been financed by local operators to treat ores from the district. Many lessees and small operators are producing in the vicinity, and it is thought that the construction of a smelter will make possible the operation of other properties that cannot now be worked profitably.

Lessees Ship from Bisbee District

Many lessees are continuing to operate in the outlying properties of the Bisbee district, in Arizona, and shipments are maintained regularly. The White Tail Deer mine is being operated by lessees, and about twenty men are employed on stoping and development work. Strikes of new orebodies have been reported recently, and the operators shipped eighteen cars of ore to the Douglas smelter during the month of February.

Work is also being continued on the Night Hawk lease, which property adjoins the White Tail Deer mine. The Crescent lease, in the Don Luis district, is working about thirty men, and shipped thirty cars of ore to the smelter during the month. Work is being conducted on the 300 and 400 levels, the ore being handled through the Wolverine shaft.

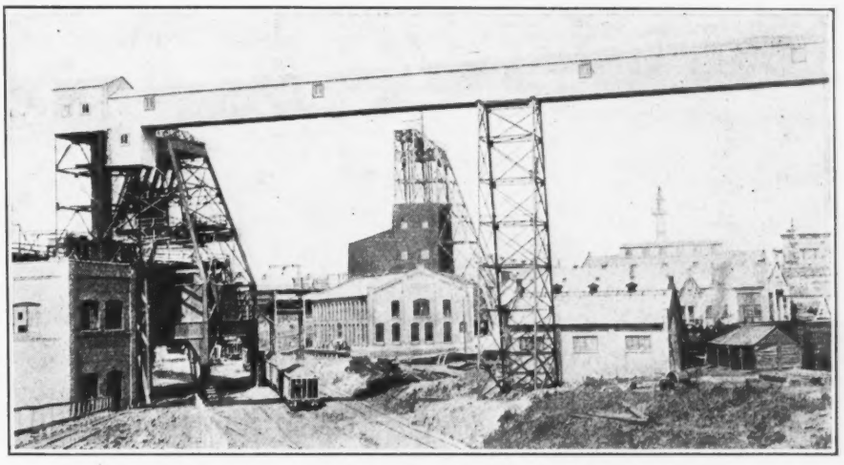
Will Resume Milling at Keller, Wash., Following Strike

At the Iron Creek mine, near Keller, Wash., the vein has been reached on the 225 level and the ore exposed in the sulphide zone. The body is 6 ft. wide, carrying 26 oz. silver and 7 per cent lead, according to J. E. Angle, manager. The shoot exposed in the upper workings and on the surface in the carbonate ores is 450 ft. long, and work is being pushed rapidly to determine the extent of the sulphide ores. Milling operations, which have been suspended for eight months, will be resumed within ten days and shipment of concentrate will be made regularly thereafter.

Pickands, Mather & Co. Expected to Manage Newport Mine

Gogebic Range Properties Involved in Change—Subsidence Causes Damage to Buildings at Newport

Charles H. Munger, vice-president and manager of iron mines for Pickands, Mather & Co., has announced that his company will hereafter handle the sale of all ores from the Newport mine at Ironwood, Mich., and the Anvil-Palms mine near Bessemer, which were acquired last summer by the Youngstown Sheet & Tube Co. Both are on the Gogebic range. Mr. Munger, who has spent several days at these mines, accompanied by W. A. Rose and W. H. Gallagher, both of Duluth, has denied rumors that changes are to be made in the local management. It is, however, generally believed that the statement that Pickands, Mather are to act as agents means that they are taking over the direction of the mines, as they have of the other Youngstown properties in the Lake Superior district, and therefore changes are to be expected.



Plant at the Newport mine, at Ironwood, Mich., for which Pickands, Mather & Co. have been made agents

Subsidence is causing considerable trouble at the Newport mine. Last summer several large fissures opened in the stockpile ground and just north of the shaft and "dry." After the shipping season a steam shovel was put in a rock pile and these fissures were filled with the rock. Now further sinking has occurred under the stockpiles and at the change house, being at one point about eight feet. The damage to the change house is such that it will have to be abandoned soon, and quarters for the men to change in are being fitted up in the large stable building. All of the buildings at this mine are of steel and brick or concrete construction, and the loss is large.

Stemwinder Has Ore, Is Report

An orebody 6 ft. wide has been struck in a tunnel in the Stemwinder prospect, 18 miles northwest of Republic, Wash., and adjacent to the old Phil Sheridan mine, a famous producer of high-grade ore, according to reports of A. C. Perrott, the owner.

Twelve New Syndicates See Portland Canal District as Goal

Bear River Section Looks Good—R. K. Niell, of Premier Fame, Again in the News

Great activity is likely to be seen in the Portland Canal mining division of British Columbia during the coming summer, if the number of companies that are being formed in Vancouver, Victoria, and Seattle to develop properties in that district may be taken as an indication. Within the last two weeks at least a dozen companies or syndicates have been organized. The Bear River section seems to be gaining in favor, mainly as a result of the excellent showing that has been made at the Dunwell mine.

There is a scramble just now to get supplies to the various properties before the snow becomes too soft for sledding. Recently a compressor and Diesel engine and other supplies arrived at Hyder for the Riverside mine, where eighteen men have been employed steadily on development work.

Rumor, which cannot be verified, has it that R. K. Niell will return to the district, having taken a bond on the Woodbine group, which is situated between the Premier mine and the Vancouver group. The owners of the property, C. Lake and D. O'Leary, are in the United States, which gives a possible ring of truth to the rumor.

As soon as the snow is off the ground, the Granby company will resume drilling operations at the Eagle group, adjoining the Outsider mine, which the company now is operating, and will start diamond drilling at the George Copper group.

Mohawk, in Michigan, Increases Force of Miners

At Mohawk, No. 1 shaft remains closed, but ground below it is being opened by drifts from No. 4. Production is coming from Nos. 4 and 6, and this centralization of operations makes for greater economies. Due to a change in labor conditions, Mohawk is showing a net gain in underground workers each month. Though many of the new men are on development work, a larger production probably will be forthcoming in the spring months.

Davis Flat Mine Reopened

The Davis Flat mine, situated 60 miles east of Fresno, Calif., on King's River, has been reopened, and operations have been resumed. The mine had been idle since the war period. The property is a small one. The mill has been repaired and shaft and tunnel retimbered. A new double-compartment shaft has been started. It is the intention of the company to install a ball mill, cyanide equipment, and a larger hoist as the development of the mine is extended.

Filtering and loading plant No. 3 shaft Concentrating plant No. 1 shaft

Butte & Superior mine plant at Butte. Production has been curtailed pending better market conditions

Butte & Superior Curtails Output

The Butte & Superior Mining Co., operating at Butte, in six days ended March 15 shipped 5,700 tons of crude zinc ore and 3,000 tons of copper ore. The company has curtailed both zinc and copper production and probably will not ship to former capacity until conditions in the metal market become better.

New Plan to Reorganize Candelaria Mines Co., in Nevada

In a circular letter to stockholders in the Candelaria Mines Co., which has been unable to operate its new mill profitably, a new plan is outlined for the further financing of development work and the paying of indebtedness to the Rochester Silver Corporation. The latter company, it seems, does not care to foreclose the mortgage on the Candelaria property, but prefers the money. A new company, called the New Candelaria Mines Co., is to be organized, and stockholders in the present Candelaria Mines Co., whose stock is now practically worthless, are asked to turn their stock in to the secretary of the new company, together with 10c. per share. In case insufficient money is raised by this method properly to finance the new company, both money and stock are to be returned to subscribers.

The board of directors of the new company includes one or two men who are successful mining engineers and operators in Nevada and elsewhere; it consists of L. D. Gordon, president and general manager; Arthur Thomas, vice-president; George B. Doyle, secretary and treasurer; Fred J. Siebert, and J. F. Thorn.

Johannesburg Letter

By John Watson

Special Correspondent

January Gold Output 796,768 Oz., Just Under Record

Average Price 97s.—Big Increase in Native Labor—Crown Mines Leads

Johannesburg, Feb. 25—The Transvaal gold output for the month of January was declared on Feb. 9 as 796,768 oz. having a value of £3,864,325. January had twenty-seven working days and the net valuation of the gold was taken at 97s. per fine ounce, that is, 3s. higher than the December value.

The above is almost a record monthly output. It was beaten only once, in 1912, when a special clean-up of ore reserves brought one month's total up to about 800,000 oz. The native labor returns show an increase of 3,880 natives working on the gold mines, as compared with December. The four largest producers are: Crown Mines, 71,592 oz.; Government Areas, 70,015; Randfontein Central, 55,162, and New Modder, 55,058.

The South African Institution of Engineers has awarded its gold medal to G. W. Sharp (member) for his paper on "The Tipping and Guiding of Vertical Skips," read last October. The Central Mining-Rand Mines Award has been made to J. A. Vaughan (past president) for his paper, on "Explosions in Air Compressors," read last March. The Ingham prize was awarded to G. T. Andrews (member) for his paper on "Home-made Apparatus for Welding Hollow Steel," read last July.

South African Townships, Mining and Finance Corporation, Ltd. (Bailey-Jeppe group) cabled, a week ago, to the London Office: "Transvaal platinum latest values very good, development excellent, future outlook encouraging. In addition to interest Transvaal Platinum Corporation has participation in other promising farms in platinum area with Transvaal Consolidated Lands." A parcel of shares (5s. full value) of Transvaal Platinum was recently sold at 92s. 6d. per share. S. A. Townships are about 13s. 6d. and Transvaal Consolidated Lands 23s. 6d.

London Letter

By W. A. Doman

Special Correspondent

Progress Made in East Rand Proprietary-Cinderella Fusion

Neither Profitable Alone, Working Agreement Expected to Make Both Earn—Overhead Cut

London, March 6—Quite recently I mentioned that reports were in circulation that the East Rand Proprietary and the Cinderella Consolidated were negotiating for a working agreement. A statement is now cabled from Johannesburg that the representatives of the two companies are making favorable progress in this direction, and that the outcome will be the provision of further working capital to bring the Cinderella again into production and at the same time to enable a longer and more economic exploitation of the East Rand Proprietary area. To a great extent the East Rand Proprietary is worked out, and funds are needed to meet the debenture service. The ore reserves are scattered, and it is necessarily a rather expensive proceeding to mine them. With a battery running on available material in the Cinderella, it should be profitable to mix with it the East Rand ore. There are few hopes that better finds will be made in the older mine, as the great area has been fairly well explored, but overhead charges should make little call on the value recovered in the event of a fusion taking place.

Cornwall Tin Companies Active

The high price of tin—at the time of writing it is £293 per ton—has certainly stimulated activity in various tin fields. In Cornwall especially are managements getting busy, and the curious thing is that in many properties good finds are being made. The latest is in the Geevor mine, where a new lode has been discovered in the Victory section, 200 ft. southwest of the Victory shaft at the fifth level. At the point of intersection the lode northeast of the drive assayed 112 lb. black tin over a width of 2½ ft., and on the southwest side 119 lb. over a width of 3½ ft. The average assay of 16 ft. driven is 92 lb. over a width of 4 ft. This is, of course, good. F. C. Cann, the general manager, suggests the probability of the lode making even above the No. 3 level. Further parallel lodes are expected, and they are believed to be a continuation of the series of lodes that exist in the Levant mine.

Zinc Contract Specifies Market Price

At the annual meeting of shareholders of the San Francisco Mines of Mexico the chairman stated that a good contract had been made for the zinc concentrates, and that the company should benefit by the fact that the demand was greater than the supply and that there would be something like a famine. It was believed at the time that the contract for the sale of the zinc concentrates had been made at a fixed price, for three or four years, but it now appears that the interpretation of the statement is that certain parties had agreed to purchase the whole output at market prices, and that only an agent's commission was being charged. This would mean that the company itself would be relieved from maintaining a selling agency and would always receive the market price for its products. This has put a different complexion upon the position, and the public, apparently, is again buying shares.

A cabled message from Johannesburg states that the government geologist has carefully re-examined the area between Boksburg and Benoni (East Rand), where the main reef is alleged to be lost. Various experts have said that this area will produce as much gold as the Rand has hitherto shown. The official states that the main reef is not faulted, but is too broken and patchy to be workable.

Pittman Resolution Calls for Immediate Purchase of 14,500,000 Oz. Silver at $1

A RESOLUTION instructing the Secretary of the Treasury to purchase an additional 14,500,000 fine ounces of silver under the Pittman Act has been introduced by Senator Pittman. This is to cover the allocations made for subsidiary coinage. Senator Pittman is of the opinion that the legislative channel promises earlier results than does an effort to secure a ruling on the question by the courts. He believes that both the Senate and the House of Representatives will support legislation setting forth that it was the intent of Congress that this 14,500,000 fine ounces of silver is to be replaced at the rate of $1 an ounce.

Chief Consolidated Shareholders Absorb $500,000 Bond Issue

THE recent $500,000 bond issue of the Chief Consolidated Mining Co., operating at Eureka, Utah, made to procure funds for the building of the new mill, has already been oversubscribed by the stockholders of the company, who are given preferential rights to subscribe for bonds until March 24, after which date the issue was to have been open to the public for subscription. The rapid absorption of these bonds is regarded with much satisfaction, as indicative of the support which may be afforded substantial mining enterprises in the state. The present issue is a new departure, inasmuch as, in the past, the financing of most mining enterprises in the state has been done through the sale of treasury stock or from profits of operation.

Washington News

By Paul Wooton

Special Correspondent

Holders of Radium Claims Relieved of Assessment

Object of Bill by Representative Brumm —Reports of Rich Congo Ores Make Situation Precarious

In an effort to assist the producers of carnotite ore and those who have sought out deposits of these ores, the Committee on Mines and Mining of the House has reported favorably on a bill by Representative Brumm, of Pennsylvania, providing for the suspension of the requirements of annual assessment work on carnotite claims for a period of three years. In recommending to the House that the bill be passed, the committee in its report points out that "a serious condition confronts the radium industry, due to the alleged discovery of ores in the Belgian Congo which contain a large percentage of radium."

"It is indicated," continues the committee in its report, "that radium can be produced from these ores at a fraction of the cost of production in America. The American supply of radium has been produced from carnotite mines located largely in Colorado and Utah. Under the law assessment work of $100 per year is required on each claim. The American companies have met these assessments, besides investing large sums in the work of production. These investments will be lost if it is true that the Belgian Congo ores are so rich in radium that it can be extracted at a greatly reduced cost. While waiting exact information, the committee believes it just to exempt these companies from assessment work required by law. The period permitted in the resolution will give time for the interests involved to decide upon their future policy."

The committee acted largely on information furnished by William A. Hardison, president of the Keystone Metals Reduction Co., of Pittsburgh; Arthur Roeder, president of the United States Radium Co., and Frank L. Hess, in charge of the rarer metals for the U. S. Geological Survey.

United Verde Extension Wins Before I.C.C.

In an opinion handed down March 22, the Interstate Commerce Commission has upheld the contention of the United Verde Extension Mining Co. that rates on classes and commodities from eastern transcontinental rate groups and from California to Clarkdale, Ariz., are unreasonable. Though the commission holds that the rates will be held unreasonable in the future, it found that the evidence did not justify a finding of unjust discrimination or undue prejudice and therefore denied reparation applying on rates in the past. The carriers, however, are expected to adjust promptly any overcharges that may be disclosed.

House Committee on Mines and Mining Will Investigate "Bureau"

Main Object to Determine Directions for Expansion—May Suggest Diversion of Wasted Energy, Too

Representative Robsion, of Kentucky, the chairman of the Committee on Mines and Mining of the House of Representatives, has taken an unusual step in calling upon his committee to consider the broad proposition of how the Bureau of Mines can be made more serviceable to the mining industry. Though there will be scrutiny of the existing activities of the Bureau to determine whether or not equivalent effort expended in other directions would be of greater practical value, the main purpose of the study will be to find out how the work of the Bureau may be expanded to greatest advantage.

It will be recalled that President Coolidge has declared himself to be in favor of a greater Bureau of Mines rather than attempting to create a Department of Mines at this time. In view of that declaration of administration policy, Representative Robsion believes that his committee is in a position to be helpful in determining the lines along which the Bureau's activities should be increased. He expresses the personal hope that there may be a decided augmentation of the Bureau's work in connection with the safety problem in coal and metal mines.

As this is written, the exact date for the conduct of these hearings has not been determined, but Chairman Robsion hopes to convene them early in April.

Senate Committee Approves Oddie's War Mineral Appropriation Bill

The Senate Committee on Mines and Mining has reported favorably, without amendment, Senator Oddie's bill authorizing an appropriation of an additional $2,500,000 "to enable the Secretary of the Interior to lawfully pay adjudicated claims arising under the provisions of the so-called War Minerals Relief Act."

Though $2,500,000 is prescribed, the bill provides that only such part of the appropriation "as may be necessary to satisfy such of the claims as shall be approved and certified for payment by the Secretary of the Interior" is to be used.

The Secretary of the Interior, in endorsing the legislation, wrote Senator Oddie as follows:

"If claims or parts of claims heretofore denied by the Secretary of the Interior are not reversed as a result of litigation now pending in the courts, the money still remaining available in the appropriation will be sufficient, or nearly sufficient, to pay the remaining unadjusted claims. If, as a result of pending litigation, items for property losses and for interest, etc., must ultimately be paid, I point out that because these items never have been allowed for payment, no statistics are available on which to predicate a statement as to the per cent of the claims likely to prevail, but it is believed from as careful an analysis as can be made, that the additional appropriation of $2,500,000 will be sufficient to take care of all claims. Whether legislation making provision for an increased appropriation largely to take care of claims now in litigation should be enacted at this time is a question which, I think, Congress and not this department should determine."

It is expected that the bill will pass Congress without serious opposition.

Seneca Skip, Loaded, Falls 1,600 Ft.; Little Damage

SHAFT CONSTRUCTION and type of skip in use in Seneca No. 1 shaft, in the Michigan copper district, recently were put to a severe test. The skip rope slipped over the sheave wheel and broke as the skip was near the top. The heavy, loaded skip tore down the shaft, carrying about 80 ft. of rope with it. It was supposed that great damage would be done the shaft, as the skip had a clear drop of 1,600 ft. before striking the curve toward the lode. The skip, however, held to the track all the way and was found at the bottom, at a depth of 2,600 ft., torn to pieces. No damage whatever was done to the shaft. The Seneca shaft is vertical for 1,650 ft., at which point it curves with the dip of the lode. The skip in use was especially designed by W. J. Uren, the superintendent, to meet these conditions. The loaded skip, in falling, attained great momentum, and it was feared it would leave the track and plunge into the shaft timber when it hit the curve. It held the rails at the turn, however, as easily as it does when under control. The episode fully demonstrates the excellence of design of a skip built for duty in a combination vertical and incline shaft.

Miami Copper Co. Thinks "Farmers" Make Good Miners

Continuing a custom that was started during the war, the Miami Copper Co. is providing a 31-acre tract of garden land for employees to use for raising vegetables. The company provides water for irrigation and employs an expert agriculturist to advise the workmen regarding the cultivation of their tracts. About eighty employees already have signed for a garden plot this year, the distribution of the tracts being in the hands of the employees' committee. The 31 acres is divided into 181 plots, estimated to be large enough to raise approximately $150 worth of vegetables. The company plows and irrigates the gardens free of cost, the men having to provide only the seeds and attend to the cultivation. Owners of plots are allowed to do as they please with their products, either use the crops themselves or sell them at the market, whichever way promises the better return.

Twelve Hydraulic Mines, Five Dredges on Yukon

Program for Coming Season—Yukon Gold and New Northwest Will Produce—Cold-Water Thawing

Operations at Dawson, Y. T., during the coming season promise but little change from those of last season. The Yukon Gold Co. will operate ten or twelve hydraulic mines and one dredge. The hydraulic mines are on the higher channels along Bonanza Creek. The dredge is operated on Gold Run Creek. The New Northwest Corporation, Ltd., will operate four dredges, two 16-cu.ft. boats on the Klondyke River and two 7.5-cu.ft. boats on Dominion Creek. This company works from two to three million cubic yards per season and has been getting satisfactory results. W. S. McFarland is manager.

The Klondyke has had a life of almost thirty years as a placer mining district. The richer deposits of the district have long ago been mined, and present operations are on the basis of large-scale dredging and hydraulic mining. Thawing of frozen ground is an important feature. The Yukon Gold Co. is using cold-water thawing and thaws in advance of mining from 18,000 to 20,000 cu.yd. per month. Conditions are not especially favorable for thawing, as the surface muck does not yield readily to any system so far devised. The bottom gravels are, on the other hand easily thawed. Water for thawing is distributed to 1,100, ⅝-in. points, by 10-in. mains, 4-in. laterals and 2-in. pipes to the manifolds, each of which serves four or five points.

In general the points are spaced 8 ft. apart one way and 9 ft. the other, and are reset between the original positions. The conditions of each area determine the details of practice. The New Northwest experimented with thawing points spaced 50 ft. apart and staggered. Holes were drilled with a Keystone drill and 2-in. pipes were used for thawing, receiving all the water that they would carry. The ground was dredged easily after one month of thawing.

High costs which are general in the Alaska-Yukon region operate to restrict the mining of lode deposits. They have increased from 100 to 200 per cent, and as a result only an exceptionally high-grade deposit can be worked. Ore of $100 per ton in value is about the limit that can be handled profitably in the Mayo district.

Trail Ore Receipts

The Consolidated Mining & Smelting Co. received the following ore shipments at Trail Smelter during the period March 8 to 14:

Name of Mine	Locality		Tons
Bosun	New Denver,	B.C.	43
Hewitt	Silverton,	B.C.	30
Knobhill	Republic,	Wash.	56
Lone Pine-Surprise-Last Chance	Republic,	Wash.	123
Paradise	Lake Windre,	B.C.	45
Quilp	Republic,	Wash.	284
Roseberry Surprise	New Denver,	B.C.	98
Silversmith, lead	Sandon,	B.C.	50
Silversmith, zinc	Sandon,	B.C.	100
Company mines	Various,	B.C.	8,871
Total			9,700

MEN YOU SHOULD KNOW ABOUT

F. W. Bradley, of San Francisco, is in Portland, Ore.

W. S. Blackman, of Bolivia, was recently in San Francisco.

H. S. Gale, engaged in oil work in California, is in the East.

William R. Jewell, consulting geologist, has moved his office to Archer City, Tex.

F. M. Hutchinson, president of the Higgins Oil & Fuel Co., of Houston, Tex., has resigned.

R. G. Wayland, superintendent of the Homestake Mining Co., at Lead, S. D., is in San Francisco.

C. D. Carmichael has been appointed superintendent of the Frood Extension mine of the Mond Nickel Co.

H. A. C. Jenison is in San Francisco on behalf of the Senate Gold and Silver Inquiry, gathering statistics on mining costs.

J. P. Dunlop, of the staff of the U. S. Geological Survey, is engaged in field work for the Senate Commission of Gold and Silver Inquiry.

E. A. Julian, general manager for the Goldfield Consolidated Mining Co. interests, was recently in Reno from his San Francisco office headquarters.

Dean J. Wolff, of Pecos, Tex., has resigned his position as geologist for the Gulf Production Co., to accept a similar position with the Mutual Oil Co., of Denver, Colo.

Clyde M. Pearce has resigned as construction engineer of the Mesabi Iron Co., at Babbitt, Minn., and accepted a position as plant superintendent with the R. M. Adams Co., at Ironton, Minn.

C. H. White, a mining engineer of San Francisco, formerly a member of Harvard faculty, was in consultation last week with U. S. Geological Survey geologists as to various metalliferous problems.

Frank Oliver, an engineer who for five years was manager of the Florence mine, is in Goldfield making an examination of the Florence mine for the new interests who have come into this company.

H. A. Thorne, superintendent of mines for the Ray Consolidated Copper Co., Chino mine, is visiting Aurora, Ill., and Marion, Ohio, inspecting new ore-handling equipment soon to be installed at the Santa Rita property.

Henry Gardner Guiterman & Co., Inc., announce the opening of offices at 25 Broadway to take over the business formerly under the direction of Kenneth S. Guiterman. After May 1 the firm will remove to 120 Broadway, New York City.

R. M. Henderson, manager of the Wellington Mines Co., at Breckenridge, Colo., is taking a month's vacation at Tonopah, Nev., combining pleasure and business, the latter in connection with some Nevada holdings of the Colorado company.

F. Albert Morrison, of the Los Angeles Stock Exchange, and **A. F. Gonnell** have been making an inspection of the Lordsburg, N. M., mining district, accompanied by **H. V. Snell**, of Globe, Ariz., who is extensively interested in mines in the vicinity of Lordsburg.

Robert H. Sayre, manager of the Arsenic Products & Refining Co., of Colorado, and western engineer for the Chipman Chemical Engineering Co., has returned to Denver from Martinez, Calif., where he has been for some time inspecting the initial operations of the California reduction works.

C. V. Corless

C. V. Corless has been appointed manager of the Victoria Syndicate, Ltd., recently organized in England, by the Mond Nickel Co. and the Central Mining & Investment Corporation, to acquire and operate Canadian mining claims.

Dr. J. C. McLennan, of the University of Toronto, is in Vancouver, B. C., with the object of securing the support of the Provincial Government of British Columbia for a plan for inducing the British Association for theAdvancement of Science to extend its Canadian visit to the Pacific.

J. E. Knapp, for many years vice-president of the Joshua Hendy Iron Works, San Francisco, has resigned his position with that firm and will enter business for himself, handling new and used mining machinery.

C. L. Dake, professor of geology at the Missouri School of Mines and Metallurgy, recently made an address before the Tulsa Geological Society, on the subject of "The Ozark Uplift." Dr. Dake outlined the chief movements of the Ozark dome in Paleozoic time, particularly with reference to the distribution and relations of the pre-Pennsylvanian formation in the Mid-Continent field.

E. L. Young, for the last three years general manager of the Sunnyside Mining & Milling Co., a subsidiary of the United States Smelting & Refining Co., which is operating in San Juan County, Colo., is in Arizona, making an investigation for his company. He will remain for a short time preliminary to taking charge of the U. S. Smelting & Refining Co.'s interests at Pachuca, Mexico. **A. B. Marquand**, former superintendent, has been promoted to the position of general manager.

Orville Dennison, executive secretary of the Massachusetts Institute of Technology, has been in Salt Lake City and vicinity recently, and while there was the guest of **Louis S. Cates**, vice-president and general manager of the Utah Copper Co., on a trip of inspection to the company's property at Bingham, and mill at Magna, personally conducted by Mr. Cates. Department heads of the state and city government, as well as local members of the alumni association of the M.I.T., were also the guests of Mr. Cates.

Jesse F. McDonald, formerly Governor of Colorado and now manager of the Down Town Mines Co., at Leadville, Colo., and president of the Colorado Metal Mining Association, recently visited Boston, New York, Washington, and Florida coast points on a wedding trip. The ex-Governor and his bride will make their home in Denver. Mr. McDonald has recently been indorsed by the Republican State Central Committee as a candidate for United States Senator to fill out the unexpired term of the late Senator Nicholson.

A. H. Hubbell, managing editor of the *Mining Journal-Press*, was in Washington March 24 and 25, attending the spring meeting of the National Conference of Business Paper Editors. The conference was addressed by Dwight F. Davis, Assistant Secretary of War, on "Industrial Preparedness"; Secretary Wallace of the Department of Agriculture; W. B. Greeley, Chief Forester; Thomas H. MacDonald, Chief of the Bureau of Public Roads; George H. Carter, Public Printer; Harry S. New, Postmaster General. The delegates were received by the President on March 24 and had a dinner that evening with Secretary Hoover at the New Willard.

OBITUARY

Thomas Southworth, managing director of the Deloro Smelting & Refining Co., Ltd., died on March 9.

H. D. Megary, managing director of the Consolidated Pneumatic Tool Co., London, England, died on March 20.

David John, a prominent citizen of Haileybury, Ont., and a pioneer of the Cobalt camp, died on March 19 after a long illness, in his fifty-fourth year. He was an assayer by profession, and a member of the Masonic order.

Harry G. Larsh, of Miami, Okla., prominent mining man of this field, was killed in a grade-crossing accident at Riverton, Kan., on March 16, and his wife and her guest, Miss Minta Garret, were dangerously injured. The motor car in which they were riding was wrecked by a passenger train. Mr. Larsh was president of the Pioneer L. & Z. Co., and formerly connected with the Toltec, Aztec, and Larsh mines, in the Picher camp.

Recent Technical Publications

Reviews, Abstracts, and References

Four British Annuals

The Mining Manual and Mining Year Book. 1924. By Walter R. Skinner. Published by Walter R. Skinner, 15, Dowgate Hill, Cannon St., London, E. C. 4, England. Price, 21s. 6d.

For most of our readers, it is only necessary to chronicle the 1924 edition of Mr. Skinner's work. To newcomers in the mining industries we may say that it gives full information regarding the more important non-ferrous metal-mining companies of the world, their officers, financial structure, and, to some extent, their technical operations. In the prospectus we note that iron and coal companies are supposed to be included, but in the book we do not find the U. S. Steel Corporation, which is the largest iron-mining organization in the world, nor some of the smaller but important American iron and steel companies. The 1924 edition of Skinner is built along familiar lines and will be found the same indispensable reference book as ever for mining investors and for others who wish information regarding the organization and standing of mining companies. From the technical standpoint, and as a reference for the smaller mines and prospects in North America, it is not nearly so complete as Weed's Handbook, a new edition of which, by the way, is needed.

The South African Mining and Engineering Journal Year Book and Directory. 1923-1924 edition. Obtainable from Argus South African Newspapers, Ltd., 82-85, Fleet St., London, E. C. 4, England. Price, 12s.

This yearbook, published by our South African contemporary, gives full details, with many illustrations, of the various mining enterprises of Africa. In appearance, it loses by the fact that advertisements are interlarded with the text, but possibly this is necessary from economic considerations. We would also suggest that the Table of Contents should be at the back of the book or, following the English customs, at the front, where it can be found easily. The function of an index is to make easy reference possible, so why hide it? The present edition of the book under review has been prepared especially with the British Empire Exhibition in mind and will form a creditable and authoritative reference book for all those in attendance who wish to know more of the great resources of the continent that cannot longer be described as altogether Dark.

Mechanical World Electrical Pocket Book. 1924. Emmott & Co., Ltd., 65 King St., Manchester, England. Price, 1s. 6d.

As usual, this little book contains much more material of interest to electrical engineers than its price would indicate. It is really quite a complete little handbook, with new or rewritten chapters on accumulators, testing sets, electric lamps and lighting, electricity in ships, electric welding, and electric furnaces. We were about to say that radio had been neglected, not finding the word in the index, but closer inspection reveals a five-page chapter on "Thermionic Valves."

Quin's Metal Handbook and Statistics. 1924. The Metal Information Bureau, Ltd., 79 Mark Lane, London, E. C. 3, England. Price, 5s.

This is the same valuable little book of metal statistics which has appeared in its familiar green cover now for some years. Production, imports, exports, prices, grades, and other similar data for all of the more commonly used metals are given, for the important countries concerned with each metal.

EDWARD H. ROBIE

A Study of Railway Problems

Railroads (Rates — Service — Management). By Homer B. Vanderblue and Kenneth F. Burgess. The Macmillan Company, New York. Price, $4.50.

Cost of transporting mineral products is an important element in the total cost of production of every mineral commodity in the United States. Not only is this true of the metals, but it is especially so of the non-metallics, where the bulk transported is of lesser value. Hence the mining industries are and rightly must be deeply interested in the railroads—how the rates are established, how government regulation operates, and how the roads are run. This is precisely the field covered by this book, and those mining men who wish to learn more about this fascinating subject will find the volume exceedingly helpful to them. It is a practical work and gives up-to-the-minute information about the agencies of regulation—the Interstate Commerce Commission and the individual state boards and the principles upon which the rate structure is built. One is impressed, incidentally, with the delicate nature of the rate structure and how a change in just a few rates may disturb others.

Such vital topics as railroad valuation, consolidation, services, and labor disputes are given much attention. The reader cannot help but be struck by the fair manner in which the relation of railroads, government, and shippers is presented. The authors give the facts, often supplemented with interesting comment and criticism. The book is a splendid treatise on the business of the railroads.

F. E. WORMSER.

Magnesite—"Magnesite, Commercial Sources and Trade," Trade Information Bulletin No. 184, U. S. Department of Commerce, 1924, prepared chiefly by C. G. Yale, of the U. S. Geological Survey; R. O. Hall, Acting Commercial Attaché, Athens, Greece, and E. Baldwin, Assistant Trade Commissioner, Warsaw, Poland, covers the past and present conditions in the magnesite industry, which suffered fundamental changes and readjustments as a consequence of the World War. What was primarily an Austrian pre-war industry, became pre-eminently an American industry in 1917, but has since declined in importance in America, and is reasserting itself in Austria. Mining and trade conditions are described for all domestic and foreign deposits of known value.

Petroleum—A copy of the Mid-Continent Year Book for 1923 has been received from the Mid-Continent Oil & Gas Association. It contains a 48-page account of the International Petroleum Exposition and Congress held in Tulsa last October; also, the sixth annual report of the association, the fourth annual report of the Osage Oil and Gas Lessees Association, and a brief statistical review of the Mid-Continent field and its development. In all it contains 180 pages, including several colored plates.

Patents

Roasting Furnace — No. 1,480,525. Jan. 8, 1924. L. J. Geschwind, Paris, France, assignor to Sté. A. Des Manufactures de Produits Chemiques du Nord-Etablissements Kuhlmann, Paris, France. A multiple-hearth furnace for roasting pyrite, having fixed stepped hearths, a central rotating shaft and a rake with teeth in the form of plow mold boards.

Sulphur Dioxide—No. 1,480,743. Jan. 15, 1924. G. C. Carson, San Francisco, This patent covers a method of eliminating sulphur dioxide from smelter gases. Metal sulphides are oxidized by introducing them in a finely divided condition into a heated gas of the requisite composition.

Roasting Furnace — No. 1,480,824. Jan. 15, 1924. A. T. Leavitt and C. H. Hughes, Syracuse, N. Y. An ore-roasting furnace comprising several upright roasting chambers, and horizontal flues in which gas is burned for heating by radiation.

Flotation Process — No. 1,480,884. Jan. 15, 1924. S. H. Dolbear, San Francisco, assignor to Pneumatic Process Flotation Co., New York. Pulverized ore is distributed evenly and without agitation directly in contact with a quiet body of froth having a selective retentive affinity for certain components of the ore.

Sintering Machine — No. 1,480,911. Jan. 15, 1924. R. L. Lloyd, New York, assignor to Dwight & Lloyd Sintering Co., New York. An apparatus for igniting a traveling bed of ore and thereafter sintering it.

Electric Smelting Furnace — No. 1,481,210. Jan. 15, 1924. Tokuji Kawai, Kokura, Japan. Design of an electric furnace for smelting ores, electrodes being suspended in the charge.

Chloridizing Lead-Zinc Ore—German patent No. 366,486. E. Günther. Abstracted in *Chemistry and Industry*. Part of the ore is given a chloridizing roast; the product is leached and the leach liquor purified and electrolyzed to obtain pure zinc and chlorine. A second part of the ore is treated with the chlorine, produced in the first operation, by the wet process and the resulting solution is treated in the same way as that obtained from the roasting. In this way the chlorine is continually utilized in attacking fresh portions of ore, and no byproducts are obtained.

Manganese Report Issued

M.M.S.A. Committee Finds Domestic Reserves of High-Grade Ores Inadequate—Resources of Low Grade Comparatively Sufficient

THAT the manganese mining industry of the United States will never be able to meet domestic demands, because of the inadequacy of reserves, is clearly shown in the report of the manganese subcommittee of the Mining and Metallurgical Society of America. This is one of the subcommittees of the committee on foreign and domestic mining policy.

To determine the adequacy or inadequacy of the domestic resources the committee first considers domestic requirements, putting them under two heads, metallurgical and chemical. About 95 per cent of the total amount consumed is used in making steel and, to a small extent, in foundries and for special alloys. It is used principally in three forms: ferromanganese, spiegeleisen, and manganiferous pig iron. The availability of an ore for making any one of these alloys is governed largely by its ratio of manganese to iron.

The committee, in its estimate, assumes that an output of 50,000,000 tons of steel will be reached in the United States between 1930 and 1935, requiring an amount of metallic manganese estimated at 13 lb. per ton, or 290,000 long tons. To this it adds 10,000 tons metallic manganese for the foundry business and special alloys. Translating this figure into terms of domestic ore, it gives the following:

Domestic Requirements

Grade]	Per Cent of Mn in Ore	Tons Mn Required	Conversion Loss Per Cent	Tons of Ore
Ferro	41.30	220,000	25	710,000
Spiegel	16.00	37,000	30	330,000
Mn-pig	9.75	43,000	30	630,000

The remaining 5 per cent of total manganese consumed is used in chemical industries, and the ore is therefore termed "chemical" ore. Most of it goes into dry batteries. Total pre-war requirements were about 35,000 tons.

In estimating the adequacy of domestic resources the committee first had to define "ore." With changing conditions as to cost and price, the report points out, the measure of ore reserves must also change, there being a constant shifting back and forth across the border line between ore and waste. Before the war, save for a few thousand tons, the United States had no high-grade manganese ores. With artificial war conditions, however, prices soared and standards lowered, so that in 1918 the United States produced 305,000 tons of ferro-grade ore, furnishing 23.6 per cent of the manganese used. In addition to this, 86 per cent of the manganese used in low-grade products came from domestic sources. This proved that *under artificial war conditions* the United States possessed considerable domestic resources of high-grade as well as low-grade ores.

Since the armistice, there has been a strong tendency to revert to the pre-war situation, though impeded by unsettled conditions, particularly in Europe and the Near East, and more recently by the tariff set up by Congress.

In brief, says the report, *under natural conditions* the United States has practically no commercial high-grade manganese ores.

The committee therefore has sought to find out how highly artificial conditions need be to shift important quantities of manganese-bearing material across the border line from waste to ore. It has reviewed 1,850 manganese deposits and prospects and studied all information as to their history, production, and possibilities. It was first necessary to determine upon a yardstick for measuring ore.

"The committee became convinced that a price equivalent to at least 50 per cent more than the highest price obtaining during the late war would be needed to make really considerable quantities of ferro-grade ore commercially available. The highest war price was $68 per long ton (Eastern) 50 per cent base. Applying the commodity index number of July, 1918 (namely 2, taking 1913 as 1), this is seen to be equivalent to $34 when referred to the 1913 price of $12.50. A 50 per cent advance over $34 would give $51, or, say, $50, as the *manganese index price.* It may be noted that this is four times the 1913 price and equivalent to about $80 in today's money.

"Fifty dollars manganese index price, 50 per cent base, was therefore assumed by the committee as the standard by which to measure ore. Everything was counted as ore (of ferro-grade) which could probably be produced at $50 index price for 50 per cent ore. This price does not apply to spiegel ores, but correspondingly high figures were taken for them."

Applying these assumptions to its study of ore deposits the committee arrived at the estimates of ore reserves, by classes of ore and by states, that are given in detail in the report. Summarized results are given as follows:

Domestic Resources

Grade	Reasonably Probable Reserves, Tons Ore	Average Per Cent Mn	Tons Manganese—Contained	Tons Manganese—Recoverable
Ferro	1,400,000	41.30	578,000	433,000
Spiegel	13,158,000	16.00	2,114,290	1,480,000
Mn-Pig	22,050,000	9.75	2,147,500	1,500,000
Chemical	270,000	.....	.....	.....

Study of these figures shows that the reasonably probable ferro-grade reserves, measured by the high price adopted, would last the country two years, or, if reasonable probabilities are included, a little over four years. Geological conditions are sufficiently well known to make it unlikely that other amounts of importance will be found.

Of chemical ores there would appear to be about eight years' supply, measured by the $50 index price. Much of this could be produced at lower prices.

Domestic reserves of spiegel and high manganese pig ores are more abundant, indicating thirty-five to forty years' supply.

The committee concludes that:

1. Domestic resources of ferro-grade ores are totally inadequate. No conceivably reasonable legislation can remedy this.

2. Reserves of chemical ores are adequate for tiding over an emergency, but inadequate from the point of view of continuous supply. Legislation might cause domestic needs to be furnished from domestic sources for a limited time, but the resulting depletion would seriously endanger the country in a time of possible future critical need.

3. The comparative adequacy of the reserves of spiegel and high-manganese-pig ores fairly raises the question whether some measure of protection, designed to foster their adaptation to industry, would be reasonable.

Discussing this last question, the report talks of a tariff not high enough to bring about any considerable production of domestic ferro-grade ores, but still high enough to increase the price of ferromanganese to a point where there would be a strong inducement to steel makers to substitute leaner materials, made from the more or less abundant lean domestic ores.

The conservation of high-grade manganese by substituting high-manganese pig iron for ferro in making additions to the charge is commendable, says the report, but, being already recognized as a possible economy in steel making, the practice will proceed of its own momentum, and it is doubted if it can be speeded up by a tariff on high-grade materials, which would place a burden on the steel industry.

Substitution of spiegel for ferro, on the other hand, could, no doubt, be increased by a high tariff on ferro and ferro ores, says the report. Possibly as much as a half of the total steel output could be made with spiegel. But the report points out that among steel makers there is strong prejudice against changing practice in this direction, because ferro is easier to use, surer in its results, and for these reasons cheaper.

A brief description of foreign resources, at the end, serves to show the comparative insignificance of domestic reserves, and demonstrates why the United States has drawn its supplies from these outside sources.

The subcommittee concludes:

1. The domestic resources of ferro-grade and chemical ores are so out of balance with the major foreign resources that, under natural conditions of foreign exchange, imports of such ores can be efficiently stopped only at great cost.

2. Should legislation be passed which should effect a measurable substitution of domestic for foreign ferro ores, the chief result, aside from cost, would be the dangerous depletion of reserves, which as it is are inadequate for domestic needs.

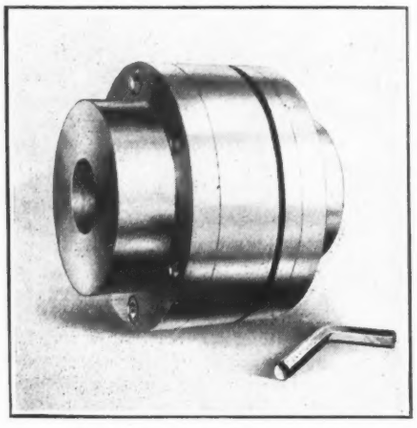
3. Domestic resources of low-grade reserves, on the other hand, are comparatively adequate. Any effective attempt, however, to force their adaptation to the country's needs beyond the normal development which may be looked for through increase in skill and a vigorous educational campaign would result in a cost so enormous as to be quite disproportionate to the purpose to be served.

The report is signed by C. M. Weld, chairman; J. W. Furness, D. F. Hewett, Robert Linton, John A. Mathews, J. V. W. Reynders and Bradley Stoughton.

New Machinery and Inventions

Two New Flexible Couplings for Wide Power Range

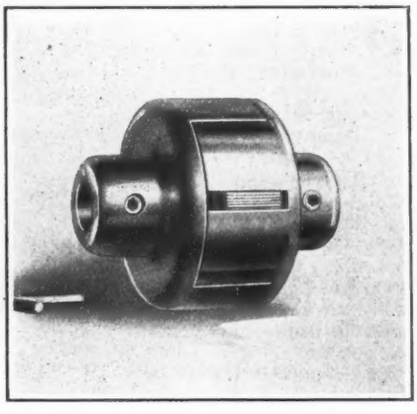
Flexible couplings for high-speed transmission, and a pressed steel type for fractional horsepower drives, have recently been added to the line of Francke flexible couplings manufactured by Smith & Serrell, Newark, N. J. The high-speed type consists of two similar flanges to be fastened to the ends of the shafts, between which are



High-speed flexible coupling

placed the flexibly connected drums. An inner drum is bolted to one flange and the outer drum to the other. Flexible laminated pins are disposed in radial holes in the inner drum and extend into slotted keepers which are located parallel to the shaft axis in the outer drum. These keepers can rotate and slide endwise in the outer drum, and the bearing of the bundles of springs or laminations is, therefore, constant and a surface bearing, instead of line or point contact. The bundles of springs can also slide in two directions so that full flexibility is obtained.

The coupling is easily accessible for inspection or repair, as the drums can be removed without disturbing either of the connected machines. This is done by simply taking out the bolts which fasten the drums to the flanges. In lining up the shafts a straight-edge may be placed across the flanges.



Pressed-steel flexible coupling for small drives

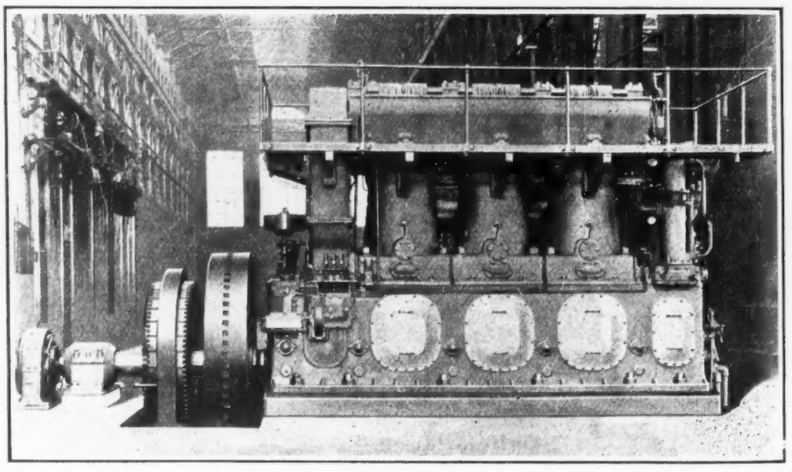
The high-speed couplings may be lubricated by either grease or oil and are built to retain the lubricant. The proper lubrication is determined by the installation and driving conditions.

These couplings are built in sizes which will transmit up to 300 hp. per 100 r.p.m., and will operate at 2,500 r.p.m. The smallest size listed will transmit 6½ hp. per 100 r.p.m., and operate at a speed of 8,500 r.p.m., maximum.

The pressed steel type is made for shafts up to ¾ in. in diameter. These couplings will transmit up to 1 hp. at 1,800 r.p.m. They consist of two similar pressed steel flanges and a center spring cross disposed between them. The coupling is flexible in all directions and extensible lengthwise. Bores smaller than ¾ in. in diameter are obtained by using inserted bushings or, in case a large number of couplings is required for a smaller shaft diameter, the bore can be drawn to fit the shaft.

Diesel Runs 202 Days Without Stopping

The high efficiency of the Diesel engine is a matter of common knowledge; but that it is able to operate continuously, without stop, is not so well known. Reliability is usually more important in any engine than is efficiency. The continuous run of 202 days, under



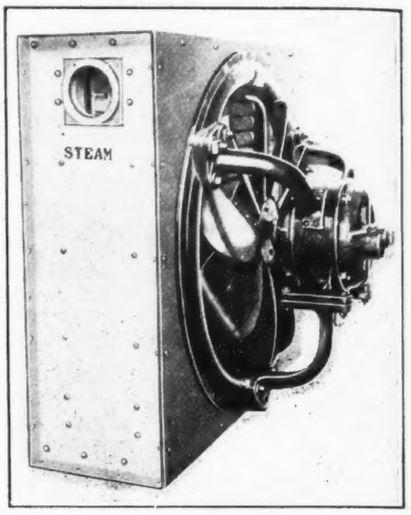
This Diesel engine hung up a record by running 202 days without stopping

actual working conditions, reported by the Worthington Pump & Machinery Corporation for a Worthington Snow Diesel engine is therefore of much interest. The engine is a standard 562 hp., four-cycle, air-injection type operating at 225 r.p.m. and is used at Horton, Kan., for city lighting and power purposes, driving an alternating-current generator in parallel with another unit. The engine has three cylinders, each 22½x22½ in. and of the so-called square type. The pistons are oil-cooled. Lubrication is forcibly fed to all parts of the engine.

In small municipal plants loads naturally vary considerably, from heavy to light. The Snow engine met all conditions without any difficulty and is said to be giving satisfaction.

A Convenient Heating Unit for Plant Shops

For those buildings about a mine plant that it may be desirable to heat and where a supply of steam is available the Venturafin unit heater made



Unit heater, using steam, for shops, storehouses, etc. Motor-driven disk fan is an integral part

by the American Blower Co., of Detroit, Mich., may prove a grerat convenience. Briefly, it consists of a steel casing containing steam coils, over which heating surface the air to be heated is forced.

Steam coils of copper and brass are used. The tubes are made of straight seamless copper and brass tubing, about which is helically wound a copper ribbon so as to form a continuous "fin." This winding is done evenly and uniformly by a patented machine. The fin is bent so as to bring a large part of its surface in contact with the outer surface of the tube, and this union is treated later so as to make fin and tube metallically integral. This, the manufacturer claims, makes the heat transmitting surface nearly five times greater than that of the tube alone.

These heaters are built of non-corrosive materials to withstand a pressure of 50 lb. and any vacuum.

THE MARKET REPORT

Daily Prices of Metals

Mar.	Copper, N. Y. net refinery*	Tin		Lead		Zinc
	Electrolytic	99 Per Cent	Straits	N. Y.	St. L.	St. L.
20	13.375@13.625	55.75	56.25	9.00	8.75	6.425
21	13.45@13.625	54.00	54.50	9.00	8.75	6.475
22	13.475	53.50	54.00	9.00	8.75	6.475
24	13.375@13.50	52.125	52.625	9.00	8.70@8.75	6.35@6.40
25	13.35	51.75	52.25	9.00	8.70@8.75	6.35@6.375
26	13.25	50.50	51.00	9.00	8.70@8.75	6.30@6.35
Av.	13.425	52.938	53.438	9.00	8.738	6.406

*These prices correspond to the following quotations for copper delivered: March 20th, 13.625@13.875c.; 21st, 13.70@13.875c.; 22d, 13.725c.; 24th, 13.625@13.75c.; 25th, 13.60c.; 26th, 13.50c.

The above quotations are our appraisal of the average of the major markets based generally on sales as made and reported by producers and agencies, and represent to the best of our judgment the prevailing values of the metals for deliveries constituting the major markets, reduced to the basis of New York cash, except where St. Louis is the normal basing point, or as otherwise noted. All prices are in cents per pound. Copper is commonly sold "delivered," which means that the seller pays the freight from the refinery to the buyer's destination.

Quotations for copper are for ordinary forms of wire bars, ingot bars and cakes. For ingots an extra of 0.05c. per lb. is charged and there are other extras for other shapes. Cathodes are sold at a discount of 0.125c. per lb.

Quotations for zinc are for ordinary Prime Western brands. Quotations for lead reflect prices obtained for common lead, and do not include grades on which a premium is asked.

The quotations are arrived at by a committee consisting of the market editors of *Engineering and Mining Journal-Press* and a special representative of the Bureau of Mines and the Bureau of Foreign and Domestic Commerce.

London

Mar.	Copper			Tin		Lead		Zinc	
	Standard		Electrolytic						
	Spot	3M		Spot	3M	Spot	3M	Spot	3M
20	65 1/4	66 1/4	71 1/2	273	273	36 1/2	35 1/4	34 7/8	34 5/8
21	66 1/4	67 1/4	72 1/2	279 1/4	279 1/4	37 1/2	36 5/8	35 1/2	35 1/8
24	64 5/8	65 5/8	71 1/2	261 1/4	261 1/4	35 3/4	35	34 5/8	34
25	65	65 7/8	71 1/2	261 1/2	261	36 1/4	35 3/8	34 5/8	33 7/8
26	64 1/4	65 1/4	71 1/2	254 3/4	254	35 1/2	34 3/4	34 1/4	33 7/8

The above table gives the closing quotations on the London Metal Exchange. All prices in pounds sterling per ton of 2,240 lb.

Silver, Gold, and Sterling Exchange

Mar.	Sterling Exchange "Checks"	Silver		Gold London	Mar.	Sterling Exchange "Checks"	Silver		Gold London
		New York	London				New York	London	
20	4.29	64	33 1/2	96s 1d	24	4.28 3/4	63 3/4	33 3/8	96s 2d
21	4.30	64 1/2	33 1/2	95s11d	25	4.29	63 3/4	33 5/16	96s 1d
22	4.29	64	33 1/2	.....	26	4.29	64	33 7/16	96s 1d

New York quotations are as reported by Handy & Harman and are in cents per troy ounce of bar silver, 999 fine. London silver quotations are in pence per troy ounce of sterling silver, 925 fine. Sterling quotations represent the demand market in the forenoon. Cables command one-quarter of a cent premium.

Metal Markets

New York, March 26, 1924

The week has been a dull one in the metal markets. London prices have declined further, tin being especially hard hit, and prices here have reflected the weakness abroad. The decline has been particularly in evidence in the last three days, which has caused buyers here to refrain from making any but the most pressing purchases until conditions appear more stabilized.

Copper

London prices advanced last Thursday and Friday, and it seemed that the copper market was to recoup some of its recent losses. Inquiries from consumers immediately became considerably more numerous, and some fair tonnages for April, May, and June shipment were booked. Most of this business was in the neighborhood of 13 3/4c. delivered, an advance of 1/8c. from last Wednesday's price, but some sellers were able to get as high as 13 7/8c. Probably the most important single order of the week was placed on Saturday; since then, with the week-end decline of £1 in London, and a further decline there of £1 today, consumers have been very skittish, and inquiries have been virtually non-existent. Most of the larger producers are nominally asking 13 3/4@13 7/8c. delivered, but one or two sellers are openly quoting 13 1/2c. for large tonnages, even this concession causing no interest on the part of buyers. Small tonnages of spot copper have been available throughout the week at prices lower than have been asked for later deliveries; today, 13 3/8c. delivered could no doubt be done for small lots for immediate delivery.

Consumption continues excellent, and most if not all of the refineries are shipping more copper this month than they are producing. Statistics should, therefore, be extremely favorable. Unfilled orders by copper manufacturers are probably not quite so large as they were a few months ago, but the situation is not at all alarming. In the last two or three weeks, buying of copper has probably not been equal to the amount of new business placed by manufacturers, so that sales should be good as soon as London prices show signs of being stabilized.

Lead

The official contract price of the American Smelting & Refining Co. continues at 9c., New York.

For the first time in some months, the 9c. price set by the leading interest is slightly above that at which lead can be obtained for in the outside market. Even prompt metal might be obtained in small tonnages for 8.90 or 8.95c., but sales at these concessions have been so small as to be insignificant, compared with the amount of lead that has been marketed under contract at the even figure. Now that the lead situation is distinctly easier, consumers show much less interest in the market, preferring to wait in the hope that the market will recede further before they have to buy. This attitude is made a safe one by the fact that both Eastern and Middle Western refiners have lead available for immediate shipment. Several inquiries have come into the market during the week, but they do not seem to have resulted in orders except in a few instances, though no objection was made to the price. At present, the market here is about on a parity with London, which means that should London decline further, prices here would have to be reduced to keep out importations.

Fundamentally, lead continues in an excellent position, and the foreign decline, as we have pointed out before, is the result of speculation rather than any sudden decrease in consumption. At present, it is of interest to note that the New York market is the highest of any in the country, with the possible exception of a few remote and small consuming centers. Lead is obtainable at other places in New York State, New Jersey, and Pennsylvania at concessions of from 10 to 20 points below the 9c. level, and in the Middle West, 8.70@8.80c. is the ruling price. Chicago rules about 2 1/2@5c. per 100 lb. above the St.

Louis market. A reduction in freight rates from the Rocky Mountain district to Middle Western and Eastern consuming points has been made, but it is too early as yet to say just how this will affect relative prices.

Zinc

The market has not been entirely lifeless, some business having been done every day, but at gradually declining prices since Saturday. As with the other metals, the reports from London were good on Thursday and Friday, but since then weakness has been apparent. Buying has been almost entirely by galvanizers. Smelters are not pressing sales, for with zinc concentrates at present prices there is said to be no profit in the business. High-grade zinc continues in good demand at from 8 to 8¾c., depending upon delivery point and seller; a good deal of this kind of metal is going abroad, Germany being included in the list of recent buyers. Spot and future prices for Prime Western are virtually the same.

Tin

The gyrations in the tin market continue, the reaction having carried the market down to below 50c. for April delivery. Yesterday, consumers began to take a little more interest in the market, but they are not yet disposed to lay in any large supplies. The high premiums on spot Straits tin continue; last Thursday they were as much as 3c. per lb., but today the difference is only about 1¼c. So far in March, deliveries have been only 1,295 long tons at American ports, many dealers being disappointed by delays due to accidents and rough weather.

Foreign Exchange

Leading interests are not participating in the foreign exchange market to any extent until conditions are more stable. The French franc has continued its upward trend during the week. On Tuesday, March 25, closing cable quotations on francs were 5.385c.; lire, 4.3175c.; and Canadian dollars, 2⅜ per cent discount.

Silver

Inquiries for China account continued quiet, New York market being steady. Demand is chiefly for India account.

Mexican Dollars—March 20th, 48⅞; 21st, 49; 22d, 48⅞; 24th, 48⅝; 25th, 48⅝; 26th, 48⅞.

Other Metals

Quotations cover large wholesale lots unless otherwise specified.

Aluminum—99 per cent grade, 28@29c. per lb.; 98 per cent, 27@28c. London, £115 per long ton.

Antimony—Per lb.
Chinese and Japanese brands, 12c.
W. C. C. brand, 13½@14c.
Cookson's "C" grade, 15c.
Chinese needle, lump, nominal, 8½@9c.
Standard powdered needle, 200 mesh, 9@10c.
White oxide, Chinese, 99 per cent Sb_2O_3, 10@11c.

Bismuth—$2.35@$2.45 per lb. London, 10s.

Cadmium—70@75c. per lb. London, 2s. 6d.

Cobalt—$2.50@$3 per lb. for spot.

Iridium—$275@$300 per oz.

Nickel—26c. per lb. for 99 per cent virgin metal. London, £130 long ton.

Osmiridium—Crude, $58.50 per oz.

Palladium—$83 per oz. Crude, $60 per oz.

Platinum—$120 per oz.
Crude platinum, $111@$113 per oz. Market easier but lifeless.

Quicksilver—$67@$68 per 75-lb. flask. San Francisco wires $63.65. London, £11½@£11½.

The prices of **Magnesium, Molybdenum, Monel Metal, Osmium, Radium, Rhodium, Selenium, Tellurium, Thallium,** and **Tungsten** are unchanged from prices given March 8.

Metallic Ores

Chrome—$19.50@$24, depending upon grade and source. Nominal.

Manganese—44@46c. per long ton unit, seaport, plus duty.

Molybdenum—80c. per lb. of MoS_2 for 85 per cent concentrates. Nominal.

Tungsten Ore—Per unit, N. Y.
High-grade wolframite, $9@$9.25.
High-grade scheelite, $10.
Ordinary grades, $8.75@$9.

Iron Ore, Magnetite, Tantalum, Vanadium, and **Zircon Ore** are unchanged from March 8 quotations.

Zinc and Lead Ore Markets

Joplin, Mo., March 22—Zinc blende, per ton, high, $46.45; basis 60 per cent zinc, premium, $43; Prime Western, $41; fines and slimes, $40@$37; average settling price, all blende, $43.49. Calamine, basis 40 per cent zinc, $24.

Lead, high, $130.45; basis 60 per cent lead, offerings $115; sellers holding for $125; average settling price, all grades of lead, $126.07 per ton.

Shipments for the week: Blende, 15,145; calamine, 64; lead, 1,628 tons. Value, all ores the week, $865,540.

Visible stocks of zinc ore have been reduced to approximately 30,000 tons. With 10,000 tons sold today, the stock of sold and unsold ore is lower than for several years. Approximately 10,000 tons was withheld from production this week because a large number of the mills were not in operation.

Platteville, Wis., March 22—Blende, basis 60 per cent zinc, $43 per ton. Lead, basis 80 per cent lead, $125 per ton. Shipments for the week: Blende, 364 tons; lead, none. Shipments for the year: Blende, 5,828; lead, 232 tons. Shipments for the week to separating plants, 686 tons blende.

Non-Metallic Minerals

Asbestos:
Crude No. 1—$300@$400.
Crude No. 2—$175@$225.
Spinning fibers—$90@$150.
Magnesia and compressed sheet fibers—$60@$90.
Shingle stock—$50@$70.
Paper stock—$32.50@$40.
Cement stock—$20@$25.
Floats—$7@$9.
All per short ton, f.o.b. mines, Quebec, tax and bags included.

Bauxite, Barytes, Beryl, Borax, Chalk, China Clay, Diatomaceous Earth, Emery, Feldspar, Fluorspar, Fuller's Earth, Garnet, Graphite, Gypsum, Ilmenite, Limestone, Magnesite, Manjak, Mica, Monazite, Ocher, Phosphate, Pumice, Pyrites, Rutile, Silica, Sulphur, Talc, Tripoli and **Zircon** are unchanged from March 8 prices.

Mineral Products

Arsenious Oxide (white arsenic)—12c. per lb.

Copper Sulphate—4.90@5c. per lb. Imported material slightly less.

Zinc Oxide—Per lb. in bags:
Lead free, 7⅞c.
5 per cent lead sulphate, 7½c.
10 to 35 per cent lead sulphate, 7c.
French, red seal, 9⅜c.
French, green seal, 10⅜c.
French, white seal, 12c.

Potassium Sulphate, Sodium Sulphate and **Sodium Nitrate** are unchanged from the March 8 prices.

Ferro-Alloys

Ferrochrome, Ferromanganese, Ferromolybdenum, Ferrosilicon, Ferrotitanium, Ferrotungsten, Ferro-uranium and **Ferrovanadium** are unchanged from the prices given in the March 8 issue.

Metal Products

Copper—Sheets, 21⅜c. base; wire, 16⅜c.

Lead Sheets — Cut, 12.75c.; full, 12.50c. per lb.

Nickel Silver—18 per cent Grade A sheets, 27½c.

Yellow Metal—Dimension sheets, 19½c.; rods, 16½c.

Zinc Sheets—Base price, $9.75 per 100 lb., f.o.b. plant.

Refractories

Bauxite Brick, Chrome Brick, Firebrick, Magnesite Brick, Magnesite Cement, Silica Brick and **Zirkite** are unchanged from the March 8 prices.

The Iron Trade

Pittsburgh, March 25, 1924

In heavy rolled products, which on the advance that ended nearly a year ago reached 2.40c. for bars and 2.50c. for shapes and plates, the two latter are now commonly going at 2.40c., except for small and undesirable orders, and 2.40c. is sometimes shaded. Bars are only moderately steady at 2.40c. In blue annealed, black and galvanized sheets two-thirds of the current sales are at a concession of $2 a ton. Full prices are obtained by the sheet subsidiary of the Steel Corporation and by some of the independents on part of their sales.

Pig Iron—Market stagnant. No business reported in bessemer or basic, and only small and occasional lots in foundry iron. Prices nominal at $23 for bessemer, $22 for basic and $23 for foundry, f.o.b. Valley furnaces.

Connellsville Coke—Spot furnace nominally at $4, with spot foundry at $5@$5.50. Though the bulk of the contracting for second-quarter furnace coke was done more than a month ago at $4.25, with a little business at $4.40 and $4.50, some producers now offer second-quarter coke at $4 and intimate that they would consider firm bids at less.

Russian Metal Production Ample to Meet Local Demand

By A. Borman

THE METAL INDUSTRY in Russia continues in the hands of the Soviet Government. It belongs to the "commanding heights" of industry which the government has declared will never be returned to the private owners. The production of this industry has increased during the last year. There were 295,000 tons of pig iron smelted (80 per cent more than during the preceding year), 610,000 tons of steel (100 per cent more) and 16,000 tons of copper (100 per cent more). But, compared with pre-war production, these figures are still exceedingly low. In proportion to the output in 1913, the production of pig iron constitutes only 7.9 per cent, of steel 13.9 per cent, and of copper 4.8 per cent.

Rykoff, the head of the Soviet nationalized industry, declares that the entire metal production for the last year will attain 20 per cent of the pre-war level, the chief part falling to the share of the metal manufacturing industry. This increase is to be explained in a considerable degree by the fact that colossal sums have been invested in it. During the last year the metal industry has received from the Commissariat of Finance 33,000,000 rubles in gold as a donation and a credit of about 30,000,000 rubles from the State Bank. These sums constitute about 29 per cent of the cost of the entire production, which the Soviet press (the *Pravda* of Jan. 3) values at 212,000,000 rubles in gold.

The metal industry has ended the year with a deficit of 30,000,000 rubles gold, and the Soviet economists are highly pleased with such a "brilliant" result.

According to the estimates for next year the profits from the whole metal industry are expected to amount to 351,000,000 rubles gold, whereas exploitation costs will be 389,000,000—that is, should even the estimates be realized in full, there will still be a deficit of 38,000,000 rubles.

Despite the comparatively insignificant production and the urgent need of metals from which the country has been suffering during the last six or seven years, the metal industry is experiencing a crisis of overproduction, for it cannot sell its present output. How far the Russian market has been reduced may be seen from the fact that, according to the calculations of the Soviet economists, during the last year the metal industry was able to realize only 80 per cent of the production, although the latter constituted but 20 per cent of the pre-war output. This reduction in the consumption may be explained on the one hand by the high costs of production and on the other by the lowered paying capacity of the purchasers. The cost of the goods has greatly increased. Thus, for instance, according to the *Economicheskaia Jizn* of Dec. 16, the production of 1 pood of pig iron (1 pood = 36 lb.) which in 1913 had cost 0.56 rubles, now costs 1.50 rubles; 1 pood of nails, instead of 2.30 rubles, now costs 6.60 rubles; that is to say, the costs of production have increased by almost three times. These high costs are called forth by a number of causes. First, the fuel has risen in price by about four times; second, the various overcharges have risen by more than three times, the bureaucratic apparatus of the nationalized industry costing much more than the enterprises cost when they were in the hands of private owners. The enterprises are working at only a part of their capacity. This part is fluctuating between 20 and 40 per cent. Naturally, under such conditions, the already high cost of the fuel is increased, every ton of production requiring from 30 to 80 per cent more fuel than in 1913.

During the last year the Soviet Government has been much occupied with the so-called concentration of the industry. Several enterprises were closed and the work was concentrated in the remaining ones. But in spite of such concentration the loading of the metal industry does not exceed 40 per cent even now.

The purchasers of metal are first of all the Soviet institutions, the Commissariat of Ways of Communication occupying the leading place among them. Naturally, this consumer has also reduced its demand, for the reason that the work of the railways has decreased by 60 per cent in comparison with that of pre-war times. Moreover, it appears that all these Soviet institutions had taken care to provide themselves with the necessary goods from abroad, thus depriving the home industry of the possibility of selling its products. This is what Rykoff says on the subject:

"A great obstacle has been up to now impeding the work of restoration of our metal industry as a result of the mistake in 1920, when large orders for railway equipment and locomotives had been placed abroad. These orders have now been reduced within the limits established by the contracts, but nevertheless they have swallowed up enormous sums, and we are now importing things that we are able to produce in our own factories. The small number of locomotives which we are constructing in our factories will be wanted only five years hence, but we have to go on constructing them in order to keep going our larger factories, such as the Kolomensky, the Sormovsky and partly the Putilovsky Works. . . . It would be impossible to close the greater part of our larger works which are now occupying a great number of our workmen, for reasons of a political, not economic, nature."

Only 25 per cent of the metal production is destined for the smaller consumer, chiefly the peasants. But the latter have lost almost all their purchasing capacity, owing to the low prices for grain, which are about half what they were before the war. At present the peasants cannot take from the metal industry even a tenth part of what they took in normal times. Thus the present greatly reduced Russian metal industry is more than sufficient for the Russian market.

Notwithstanding the fact that at present the products of the Russian metal industry are much dearer than foreign ones, the Soviet Government dares not profit by acquiring foreign goods, for purely political reasons. At the end of December the Communist party had again insisted on the necessity of reducing the import of foreign goods.

An increase in the demand for metal products can only take place in the event of a general restoration of the whole economic life of the country. An absolutely necessary condition of such a restoration is the liberation of the country from the economic pressure exercised by the Soviet Government and particularly the abolition of such pressure on the prices for grain. It is impossible to have a good market in a country where a large part of the population is unable to sell the products of its labor in a free market, but is forced to give them up at prices which have been artificially and greatly lowered.

Mining Dividends for March

The following dividends were paid by mining and metallurgical companies during March:

Companies in the United States	Situation	Per share		Total
American Metal	U. S. and Mex.	$0.75	Q	$402,000
American Metal pfd	U. S. and Mex.	1.75	Q	87,500
American Smelting & Refining pfd	U. S. and Mex.	1.75	Q	875,000
Calumet & Arizona, c	Ariz.	0.50	Q	321,261
Eagle-Picher Lead, l,z	Various	1.50		270,000
Federal Mining & Smelting pfd., s,l	Idaho	1.75	Q	210,000
Hecla Mining, s,l	Idaho	0.25	Q	250,000
Homestake Mining, g	S. D.	0.50	M	125,580
Inland Steel	Minn.	0.625	Q	629,379
National Lead	Various	2.00	Q	413,108
National Lead pfd	Various	1.75	Q	426,433
St. Joseph Lead	Mo.	0.50	Q	774,684
Sloss-Sheffield Steel & Iron	Ala.	1.50		150,000
Texas Gulf Sulphur	Texas	1.75	Q	1,111,250
U. S. Steel	Various	1.75	Q	8,895,294
United Verde Copper	Ariz.	2.00	Q	600,000
Utah Copper	Utah	1.00	Q	1,624,490
Companies in other countries				
Chile Copper	Chile	0.625	Q	2,375,000
Hollinger Consolidated Gold	Ont.	0.05	4 wks.	246,000
Keeley Silver	Ont.	0.12		240,000
Total		.....		20,026,979

The dividends paid in March are about $5,000,000 less than those paid for the preceding quarter, in December. The principal reason for this is the fact that some companies that do not make regular quarterly distributions made payments in December, that of the Great Northern Iron Ore Properties, for example, totaling $3,000,000, and that of the Mother Lode Coalition, of $1,250,000. The most important dividend disappointment of the month was the passing of the Calumet & Hecla disbursement, 50c. having been paid in December. Texas Gulf Sulphur paid $1.75, instead of $2. On the other hand, U. S. Steel paid $1.75 instead of $1.50, and the good condition of the iron and steel industry was also exemplified by the payment of $1.50 by the Sloss-Sheffield company, the first to be paid on the common stock of that company since February, 1921.

Company Reports

Superior & Boston Copper Co.

Copper; Copper Hill, Ariz.

A report of the operations of the Superior & Boston Copper Co. for the three months ending Dec. 31, 1924, states that 1,614 ft. of development work was done, compared with 1,581 ft. during the previous quarter. This average is somewhat in excess of the present rate, which is about 500 ft. per month.

The company has shipped 6,436 dry tons of ore to the International smelter, at Miami. This ore averaged 4.38 per cent copper and 10.55 oz. silver, and contained 564,132 lb. of copper and 67,921 oz. silver. Receipts, in net smelter returns, were $66,809, after deducting freight and treatment charges, or an average of $10.38 per ton. In the second quarter of 1922-23, shipments were 64,000 lb. less copper and 1,200 oz. less silver, and yet in that period $30,600 more in smelter returns was received.

Shipments, expressed in tonnage, came from the different veins in the following proportions: Footwall vein, 60 per cent; Rigby vein, 17 per cent; and Dewey vein, 23 per cent.

During December, the International smelter, at Miami, found itself unable to use as much ore as had been shipped to it, and the company was forced to curtail production. It is hoped, however, that this condition will not be of long duration.

Recent reductions in smelting charges and freight rates on El Paso shipments have made it possible to ship to the smelter at that point, and accordingly certain classes of ore amounting to about half of the present production are now being diverted there.

Howe Sound Co.

Copper, lead, silver; British Columbia and Mexico

A report of the operations of the Howe Sound Co. and its subsidiaries for 1923 states that there has been no change in the company's "Share Investment" account, which is made up of the following securities: 91,966 shares (all) of the outstanding capital stock of Britannia Mining & Smelting Co., Ltd.; 53,800 shares (out of 60,000 shares outstanding) of the capital stock of El Potosi Mining Co.; and 194,774 shares (all) of the outstanding capital stock of Calera Mining Co.

After a cessation of production lasting two years, on account of the destruction of its concentrator by fire on March 19, 1921, operations at the company's Britannia property on a commercial scale were resumed in March last and continued without interruption with improving metallurgical results in the operation of the new 2,500-ton concentrating mill.

Operations at El Potosi property were uninterrupted except for two weeks during September, when labor difficulties at the Chihuahua smelter forced a suspension of production during that period. The directors have under consideration the construction of a 500-ton concentrating plant on the company's property for the treatment of the low-grade sulphide ores available in the Potosi mine; also, electrification of the mine and railroad is contemplated. The program involves a large expenditure, but a mill is necessary in order to reclaim the company's ores that are not of a direct shipping grade, and electrification of the plant will result in greater efficiency and economy throughout the entire operation.

Further metallurgical tests on the ores of the Calera Mining Co. were completed, confirming the previous results and giving assurance that satisfactory savings can be effected by concentration.

The large reconstruction program at Britannia, made necessary by the destructive fire, was completed soon after the first of the year, and the new concrete and steel mill was placed in full operation in March, producing 22,477,317 lb. of copper during the rest of the year, exceeding the production of any previous calendar year by 4,154,835 lb. Notwithstanding an acute shortage of competent underground labor, the necessity for breaking in a new mill crew and, from time to time, serious shortage of water for power purposes, operating costs show a steady decline throughout the year.

The ore reserves of the Britannia mine total 6,495,130 tons, averaging 2.1 per cent copper; of this tonnage 1,613,440 tons are broken in stopes upon which all mining costs (labor, supplies, explosives, power, etc.) have been applied, exclusive of tramming to Rock Raise.

A power-transmission line, constructed by the British Columbia Electric Ry. between North Vancouver and Britannia Beach, was completed on Dec. 27, and electrical energy from that source was made available on Jan. 1, 1924.

The mine production of carbonate and sulphide ores at El Potosi averaged 17,500 tons per month, the decreased production during the year being due to shortage of labor and the increased amount of development work carried on throughout the mine. There were mined and shipped during the year 214,228 dry tons (of 2,000 lb.) as compared with 229,367 dry tons for 1922, containing 2,882,416 oz. of silver and 25,798,712 lb. of lead.

Aside from the production and shipment of a small tonnage of ore for experimental purposes no operations were conducted at the Calera property during the year.

Balance Sheet, Dec. 31, 1923

Assets

Fixed		
Mining property:	$8,144,871.78	
Plant, buildings and machinery	6,716,646.46	
Investments	923,670.70	
		$15,785,188.94
Deferred charges		406,625.22
Reserve fund		195,302.02
Current		
Inventories	601,243.09	
Accounts receivable	260,773.83	
Product on hand	29,260.47	
U. S., Canadian and other bonds	2,037,598.15	
Cash	87,387.30	
		3,016,262.84
		$19,403,379.02

Liabilities

Capital stock		$1,984,150.00
Authorized issue 3,000,000 shares, par value $1—1,984,150 shares issued.		
Twenty-year 6 per cent gold bonds		3,228,000.00
Outstanding Dec. 31, 1922	$3,497,000.00	
Redeemed Oct., 1923	269,000.00	
Reserves		8,528,702.43
Depreciation and depletion	$7,925,071.78	
Insurance	592,603.86	
Workmen's compensation	11,026.79	
Profit and loss		4,744,311.46
Balance as at Dec. 31, 1922	$5,033,218.20	
Adjustment a/c previous years	358,541.73	
Adjusted balance	$4,674,676.47	
Profit for 1923	367,257.49	
Dividends Nos. 13, 14 and 15 —15c per share $297,622.50	69,634.99	
Current liabilities		918,215.13
Accounts payable	269,007.63	
Dividend No. 15 payable Jan. 15, 1924	99,207.50	
Notes payable—banks	550,000.00	
		$19,403.379.02

Profit-and-Loss Account

Mining	$1,797,137.04
Transportation	264,252.38
Milling	506,800.60
Smelting and marketing	2,097,528.64
Administration	180,581.29
Taxes	164,413.75
Balance	1,417,243.60
	$6,427,957.30
Depreciation and depletion	857,545.40
Interest	192,440.71
Balance	367,257.49
	$1,417,243.60
Smelter returns	$6,215,585.46
On Copper 22,477,317 lb.	
Lead 25,798,712 lb.	
Silver 2,991,380 oz.	
Gold 4,875 oz.	
Miscellaneous income	212,371.84
	$6,427,957.30
Balance brought down	$1,417,243.60
	$1,417,243.60

Calumet & Hecla Consolidated Copper Co.

Copper; Michigan

A report of the operations of the Calumet & Hecla Consolidated Copper Co. for Sept.-Dec., 1923, shows a loss of $596,497.48. The consolidation of the Ahmeek, Allouez, Calumet & Hecla, Centennial and Osceola Consolidated mining companies became effective as of Sept. 1, 1923.

For the eight months of the year previous to that date there was produced: From Ahmeek, 17,811,031 lb. of copper; from Calumet & Hecla, 24,413,600 lb.; and from Calumet & Hecla reclamation work, 10,634,200 lb. For the four months of the year after Sept. 1 there was produced from the mines 21,259,000 lb. of copper at an average cost sold, but not including depreciation and depletion, of 11.45c. per lb.

During the same period there was produced from Calumet & Hecla reclamation 6,267,000 lb. of copper at an average cost sold of 8.56c. per lb.

The price received for copper delivered during the four months' period from Sept. 1 through Dec. 31 was 13.58c. per lb.

Earnings Statement—Sept.-Dec., 1923

Receipts

Copper sales	$2,540,053.73	
Custom milling, smelting and refining	21,247.84	
Dividends	21,559.65	
Interest	77,254.13	
Miscellaneous	23,371.42	
		$2,683,486.77

Disbursements

Copper on hand Sept. 1, 1923	$3,672,555.02	
Production, selling, administration and taxes	2,931,283.79	
Depreciation and depletion	1,319,930.48	
Miscellaneous	172,709.59	
	$8,096,478.88	
Less copper on hand end of year	4,816,494.63	
		3,279,984.25
Loss for period		$596,497.48

Balance Sheet as of Dec. 31, 1923

Assets

Current assets			
Cash		$1,008,358.97	
Liberty bonds at par		1,632,850.00	
U. S. certificates of indebtedness		450,000.00	
Notes receivable		322,727.85	
Accounts receivable		2,678,485.68	
Copper on hand		4,816,494.63	
Prepaid charges		87,228.70	
Supplies at mine (book value)		4,034,266.94	
			$15,030,412.77
Investments in other companies (book value)			2,034,865.33
Capital assets (book value)			
Real estate, stumpage and timber		$4,460,034.36	
Mine lands	$52,542,942.07		
Less reserve for depletion	877,723.71		
		51,665,218.36	
Plant	$28,414,853.97		
Less reserve for depreciation	12,169,650.19		
		16,245,203.78	
Stamp mill patents		40,403.19	
			72,410,859.69
Total assets			$89,476,137.79

Liabilities

Current liabilities			
Accounts payable			$1,266,818.34
Capital stock			
Authorized	2,500,000 shares par $25.00	$62,500,000.00	
Less not issued	494,498 shares par $25.00	12,362,450.00	
Issued	2,005,502 shares par $25.00	full paid	50,137,550.00
Surplus			
Paid-in surplus Sept. 1, 1923		$39,671,017.93	
Loss by 1923 operations (four months)	$596,497.48		
Dividend paid	1,002,751.00	1,599,248.48	38,071,769.45
Total liabilities, capital and surplus			$89,476,137.79

Investments in other companies as shown in balance sheet include stock holdings of copper companies located in Michigan, as follows:

	Shares
28,785 shares Cliff Mining Co.	of a total issue of 60,000
35,000 shares Isle Royale Copper Co.	of a total issue of 150,000
152,977 shares La Salle Copper Co.	of a total issue of 302,977
50,100 shares Superior Copper Co.	of a total issue of 100,000
10,000 shares White Pine Copper Co., preferred	of a total issue of 10,000
42,602 shares White Pine Copper Co., common	of a total issue of 85,320

One dividend of 50c. per share totaling $1,002,751 was paid.

Engels Copper Mining Co.

Copper; Engelmine, Calif.

A report of the operations of the Engels Copper Mining Co. for 1923 shows a net profit of $236,713.25. Production is given as follows:

14,450,243 lb. copper—gross value	$2,081,357.11
165,441 oz. silver—gross value	125,601.61
2,592 oz. gold—gross value	49,243.16
Total	$2,256,201.88

Copper production for 1922 was 14,075,947 lb. The foregoing therefore shows an increase of 374,296 lb. compared with last year.

The report states that during the last year the company paid off all indebtedness amounting to about $270,000 and expended $347,387.44 on new construction and development work, leaving balance of cash assets on hand Dec. 31 of $133,216.04. The No. 10 level project is nearing completion. This has been a long and strenuous undertaking, costing over $400,000, and paid for entirely from earnings in the face of an extremely depressed copper market save for a few months last year. Excellent bornite ore has been disclosed on this level, assuring a material increase in proven ore reserves when the intermediate levels are opened. Operating cost should be still further reduced, which will result in increased net earnings, and which will, of course, be further increased by whatever advance there may be in the price of copper above the present low level.

Profit-and-Loss Statement

Net receipts from concentrates delivered to smelter		$1,467,786.74	
Concentrates in transit		52,735.51	
Total value of production			$1,520,522.25
Sundry profits			23,929.42
Total earnings			$1,544,451.67
Less operating expense			
Mining ore	$635,338.35		
Milling ore	317,111.73		
Aerial tramming	19,896.58		
Marketing	7,164.14		
Crushing	11,756.55		
General mine	11,294.81		
General expense—S. F.	41,078.94		
Taxes, interest, insurance	35,161.70		$1,078,802.80
Operating profit			$465,648.87
Less development			95,675.25
			$369,973.62
Reserves			
Depreciation		$100,180.36	
Liability for compensation		33,080.01	133,260.37
Balance to profit and loss			$236,713.25
Profit and loss, Dec. 31, 1922	$20,505.06		
Charges against profit and loss	20,804.81		299.75
Profit and loss, Dec. 31, 1923			$236,413.50

Balance Sheet as of Dec. 31, 1923

Assets			
Mines, mining claims, ranch lands, etc.			$1,346,713.91
Plant and equipment			1,400,773.96
Current working assets and deferred charges			$1,184,955.66
Current working assets		$780,695.81	
Material and supplies	$131,301.74		
Mercantile department	63,857.09		
Ore broken in stopes	433,199.96		
Accounts receivable	5,818.48		
Notes receivable	13,302.50		
Cash assets	133,216.04		
Cash in bank	$80,480.53		
Concentrates in transit	52,735.51		
Deferred charges		404,259.85	
Investments			
Indian Valley R.R. stock (at par)			410,000.00
			$4,342,443.53

Liabilities

Capital stock			
Authorized	$5,000,000.00		
Unissued	2,303,334.00		
Issued and outstanding			$2,696,666.00
Reserves			1,281,942.46
Depreciation		$617,581.70	
Depletion		589,060.84	
Liability for compensation		75,299.92	
Current			125,729.00
Accounts payable		78,424.54	
Payroll—accrued		47,304.46	
Unclaimed wages			1,692.57
Profit and loss			236,413.50
			$4,342,443.53

Cost of production was 12.931c. per lb. net, including depreciation and gold and silver credits.

MINING STOCKS

Week Ended March 22, 1924

Stock	Exch.	High	Low	Last		Last Div.
COPPER						
Alaska-Br. Col.	N. Y. Curb	....	....	*40	....	....
Anaconda	New York	33⅞	32	32⅛	De.15, Ja.21, Q	0.75
Aracadian Consol.	Boston	1⅛	1⅛	1⅛	....	....
Ariz. Com'l	Boston	9½	9	9	Ja.15, Ja.31	0.50
Calaveras	N. Y. Curb	1⅛	1⅛	1⅛	....	....
Calumet & Arizona	Boston	43½	42½	43½	Mc.7, Mc.24, Q	0.50
Cal. & Hecla (New)	Boston	15½	15½	15½	De. 1, De. 17	0.50
Canario Copper	N. Y. Curb	2⅛	2	2⅛	....	....
Cerro de Pasco	New York	46	44⅛	44⅛	Ja. 17, Feb. 1	1.00
Chile Copper	New York	27⅛	26⅛	26⅛	Mc.1 Mc.29, Q	0.62½
Chino	New York	16⅛	15½	15½	Sept. '20, Q	0.37½
Con. Coppermines	N. Y. Curb	2⅛	2⅛	2⅛	....	....
Copper Range	Boston	23½	22⅛	22⅛	May '23, Q	1.00
Crystal Copper	Boston Curb	75	71	72	....	....
Davis-Daly	Boston	4⅛	4 5/16	4 1/16	Mar. '20, Q	0.25
East Butte	Boston	5	2⅛	2⅛	Dec. '19, A	0.50
First National	Boston Curb	29	26	29	Feb. '19, SA	0.15
Franklin	Boston	*90	*90	*90	....	....
Gadsden Copper	Boston Curb	*35	*33	*33	....	....
Granby Consol.	New York	15	13½	14½	May '19, Q	1.25
Greene-Cananea	New York	14⅞	14	14	Nov. '20, Q	0.50
Hancock	Boston	1⅛	1	1	....	....
Howe Sound	N. Y. Curb	2⅛	2⅛	2⅛	Ap.1, Ap.15, Q	0.05
Inspiration Consol.	New York	24⅛	23	23⅛	De.20, Ja.7, Q	0.50
Iron Cap	Boston Curb	....	....	3	May 23, K	0.15
Isle Royale	Boston	15⅜	15⅛	15⅛	Se. 1, Se. 15,	0.50
Jerome Verde Dev.	N. Y. Curb	1⅛	1	1	....	....
Jib Consol.	N. Y. Curb	32	15	28	....	....
Kennecott	New York	36	35	35⅛	Mc.7, Ap. 1, Q	0.75
Keweenaw	Boston	1	1	1	....	....
Lake Copper	Boston	1⅛	1⅛	1⅛	....	....
Magma Copper	New York	35⅛	33⅛	33⅛	Jan. '19, Q	0.50
Mason Valley	N. Y. Curb	1⅛	1⅛	1⅛	....	....
Mass Consolidated	Boston	*80	*70	*70	Nov. '17, Q	1.00
Miami Copper	New York	22	21	21	Fe. 1, Fe. 13, Q	0.50
Michigan	Boston	....	....	*50	....	....
Mohawk	Boston	*32	*31	*31⅛	Se. 22, Oc. 13,	1.00
Mother Lode Coa	New York	8⅛	7⅞	8	De.14, De.31	0.50
Nevada Consol.	New York	13⅛	12⅛	12⅞	Sept. '20, Q	0.25
New Cornelia	Boston	*17	*17	*17	Au.3, Au.20, Q	0.25
New Dominion	N. Y. Curb	2⅛	2⅛	2⅛	....	....
North Butte	Boston	2⅛	2⅛	2⅛	Oct. '18, Q	0.25
Ohio Copper	N. Y. Curb	*72	*67	*70	....	....
Old Dominion	Boston	17	17	17	Dec. '18, Q	1.00
Osceola	Boston	....	....	31⅛	June '23, Q	1.00
Phelps Dodge	Open Mar.	†135	†120	....	Mc.24, Ap.2 Q	1.00
Quincy	Boston	....	....	20	Mar. '20, Q	1.00
Ray Consolidated	New York	10	9⅛	9⅛	Dec. '20, Q	0.25
Ray Hercules	N. Y. Curb	*17	*15	*15	....	....
St. Mary's Min. Ld.	Boston	*31	*30⅛	*30⅛	No.9,De.11,K	1.00
Seneca Copper	New York	4⅛	3⅛	3⅛	....	....
Shannon	Boston	*45	*45	*45	Nov. '17, Q	0.25
Shattuck Arizona	New York	5⅛	5⅛	5⅛	Jan. '20, Q	0.25
South Lake	Boston	....	....	*25	....	....
Superior & Boston	Boston	*80	*75	*75	....	....
Tenn. C. & C. cfs.	New York	7⅛	7⅛	7⅛	De.31, Ja.15, Q	0.25
Tuolumne	Boston	....	....	*42	May '13,	0.10
United Verde Ex.	N. Y. Curb	25⅛	24⅛	24⅛	Ap.1, May 1, Q	0.50
Utah Copper	New York	67⅛	65⅛	65⅞	Mc.14, Mc.31,Q	1.00
Utah Metal & T.	Boston	*40	*40	*40	Dec. '17,	0.30
Victoria	Boston	*65	*65	*65	....	....
Walker Mining	N. Y. Curb	3⅛	3	3	....	....
Winona	Boston	*35	*25	*30	....	....
Wolverine	Boston	....	....	5⅛	....	....
NICKEL-COPPER						
Internat. Nickel	New York	13⅛	13⅛	13⅛	Mar. '19,	0.50
Internat. Nickel pfd.	New York	80⅛	80⅛	80⅛	Ja.17, Fe.1, Q	1.50
LEAD						
Carnegie Lead & Zinc	Pittsburgh	3	2⅛	3	....	....
National Lead	New York	147	140⅛	144	Mc.14,Mc.31,Q	2.00
National Lead pfd.	New York	114⅛	114	114⅛	No. 23, De. 15	1.75
St. Joseph Lead	New York	26	24⅛	25⅛	Mc. 20,24	0.50
ZINC						
Am. Z. L. & S.	New York	8⅛	7⅛	7⅛	May '20	1.00
Am. Z. L. & S. pfd.	New York	30	25	25⅛	Nov. '20, Q	1.50
Butte C. & Z.	New York	5	5	5	Mai. '23,	0.50
Butte & Superior	New York	17	16⅛	16⅛	Je.15, Je. 30, Q	0.50
Callahan Zn-Ld.	New York	4⅛	4⅛	4⅛	Dec. '20, Q	0.50
New Jersey Zn.	N. Y. Curb	....	....	151⅛	Ja.31, Fe.9	2.00
United Zinc	N. Y. Curb	....	....	*25	....	....
Yellow Pine	Los Angeles	*75	*75	*75	Dec. '23	0.03
SILVER						
Alvarado	N. Y. Curb	....	....	1⅛	....	....
Batopilas Mining	New York	....	....	⅛	Dec. '07, I	0.12
Beaver Consol.	Toronto	*30	*29½	*29½	May '20, K	0.03
Castle-Trethewey	Toronto	*78	*73½	*75¼	....	....
Coniagas	Toronto	2.30	2.30	2.30	Oc.19,No.1,'23	0.02⅞
Crown Reserve	Toronto	†*64	†*63½	*64	Jan. 17,	0.05
Kerr Lake	N. Y. Curb	....	....	1⅞	Ap.1, Ap. 15, Q	0.12½
La Rose	Toronto	†*20¼	†*19½	*19	Apr. '22,	0.10
McKinley-Dar.-Sav.	Toronto	†*16	†*15½	*15	Oct. '20, Q	0.03
Mining Corp. Can.	Toronto	3.53	3.47	3.48	Sept. '20, Q	0.12½
Nipissing	N. Y. Curb	6⅞	6⅛	6⅛	Mc.1, Ap.21, Q	0.03
Ontario Silver	New York	6	6	6	Jan.'19, Q	0.50
Temiskaming	Toronto	†*31	†*31	*30	Jan. '20, K	0.40

Stock	Exch.	High	Low	Last		Last Div.
GOLD						
Alaska Gold	New York	⅛	⅛	⅛	....	....
Alaska Juneau	New York	1½	1	1½	....	....
Carson Hill	Boston	1⅜	1⅛	1⅜	....	....
Cresson Consol. G.	N. Y. Curb	4	3⅛	4	De.31, Ja.10, Q	0.1
Dome Mines	New York	18	17⅛	17⅞	Mc.26,Ap.21,Q	0.5
Golden Cycle	Colo. Springs	1.29	1.27	1.29	De.'22, Q	0.0
Hollinger Consol.	Toronto	†12.00	†11.95	12.10	Mc.6, Mc.24, M	0.0
Homestake Mining	New York	50	49⅛	49⅛	Mc.20,Mc.25,M	0.5
Kirkland Lake	Toronto	*22⅛	*21	*22⅛	....	....
Lake Shore	Toronto	†3.86	†3.82	3.81	Fe.2, Fe.24, Q	0.02
McIntyre-Porcupine	New York	16	15⅛	15⅞	De. 1, Ja. 2,	0.25
Portland	Colo. Springs	*52	*50	*52	Oct. '20, Q	0.01
Teck-Hughes	N. Y. Curb	1⅛	1 3/16	1 1/16	....	....
Tom Reed	Los Angeles	*38⅛	*37⅛	*38⅛	Dec. '19,	0.02
United Eastern	N. Y. Curb	*89	*84	*88	Ja.8, Ja.28, Q	0.15
Vipond Cons.	Toronto	†1.24	†1.21	1.20	....	....
Wright-Hargreaves	Toronto	3.10	3.00	3.08	Mc.15, Ap. 1,Q	0.02½
Yukon Gold	N. Y. Curb	*63	*60	*61	June '18,	0.02
GOLD AND SILVER						
Con. Cortez	N. Y. Curb	*50	*40	*46	....	....
Con. Virginia	San Francisco	*3⅛	*3⅛	*3⅛	....	....
Continental Mines	N. Y. Curb	....	....	1⅛	....	....
Dolores Esperanza	N. Y. Curb	*55	*55	*55	Jy. 1, Jy. 10 Q	0.05
Premier Gold	N. Y. Curb	2	2	2	....	....
Tonopah Belmont	N. Y. Curb	*62	*59	*60	Apr. '23, Q	0.05
Tonopah Divide	N. Y. Curb	*32	*32	*32	Se.22, Oc. 10	0.10
Tonopah Extension	N. Y. Curb	1⅛	1⅛	1⅛	Mc. 11, Ap. 1	0.05
Tonopah Mining	N. Y. Curb	1 1/16	1⅛	1⅛	Ap. 6,Ap. 21	0.07½
Unity Gold	N. Y. Curb	1⅛	1⅛	1⅛	....	....
West End Consol.	N. Y. Curb	*66	*66	*66	Mar. '23, Q	0.05
SILVER-LEAD						
Ahumada	Boston Curb	5⅛	5	5⅛	Mc., Ap. 2,	0.07½
Bingham Mines	Boston	....	....	16½	Sept. 19, Q	0.25
Cardiff M. & M.	Salt Lake	....	....	1	Dec. '20,	0.15
Chief Consol.	Boston Curb	4	3	3	Ja.11, Fe.1, Q	0.10
Columbus Rexall	Salt Lake	*27½	*26	*27½	Aug. '22	0.03
Consol. M. & S.	Montreal	37⅛	37	37⅛	Oct. '20, Q	0.62½
Daly Mining	Salt Lake	2.15	2.10	2.15	July '20	0.10
Erupcion	Boston Curb	2⅛	2	2⅛	Mc. 15, Ap.2,	0.07½
Federal M. & S.	New York	11	11	11	Jan., '09	1.50
Federal M. & S. pfd.	New York	46½	43⅛	43⅛	Fe.26,Mh.15,Q.	1.75
Florence Silver	Spokane	*21	*20	*20	Apr. '19, QX	0.01
Hecla Mining	N. Y. Curb	9⅛	9⅛	9⅛	Fe.15,Mh.15Q	0.25
Indian Mines	N. Y. Curb	....	....	*64	....	....
Iron Blossom Con.	N. Y. Curb	....	....	*31	Oct. 26, '23,	0.02
Marsh Mines	N. Y. Curb	....	....	*11	June '21, I	0.02½
Park City	Salt Lake	....	....	4.75	Mc.15, Ap.1	0.15
Park Utah	N. Y. Curb	3⅛	3⅛	3⅛	Mc.15, Ap.1	0.15
Prince Consol.	Salt Lake	....	....	*75	Nov. '17,	0.02
Silversmith	Spokane	†*38⅛	†*39⅛	*39⅛	De. 31, Ja. 10	0.02
Tamarack-Custer	Spokane	1.83	1.73	1.74	Se.30, Oc. 1, K	0.02
Tintic Standard	Salt Lake	4.60	4.35	4.35	Mar. 25,24, QX	0.15
Utah-Apex	Boston	2⅛	2⅛	2⅛	June '23, QX	0.50
IRON						
Bethlehem Steel	New York	55⅛	51⅛	52⅛	Mh. 1, Ap. 1, Q	1.25
Char. Iron	Detroit	⅜	⅜	⅜	....	....
Char. Iron pfd.	Detroit	1⅛	1⅛	1⅛	....	....
Colorado Fuel & Iron	New York	34	31⅛	31⅛	Fe.11, Fe.25 Q	2.00
Col. Fuel & Iron pfd.	New York	....	....	102	Fe.11, Fe.25, Q	2.00
Gt. North'n Iron Ore	New York	30	29⅛	29⅛	De.10, De.27	2.00
Inland Steel	N. Y. Curb	....	....	46	Mh.15, Apl. 1 Q	0.62½
Mesabi Iron	N. Y. Curb	....	....	6	....	....
Replogle Steel	New York	10⅜	9⅛	9⅛	....	....
Republic I. & S.	New York	55⅞	48	49⅛	May '21	1.50
Republic I. & S. pfd.	New York	91⅛	88	88	Mh.20,Ap.1QX	2.75
Sloss-Sheffield S.&I.	New York	61	58	59⅛	Mc.10, Mc.20	1.50
Sloss-Shef. S.&I.pfd.	New York	....	....	84	De.20, Ja.2, Q	1.75
U. S. Steel	New York	102⅛	98⅛	98⅞	Mc. 29, QX	1.75
U. S. Steel pfd.	New York	119⅛	118⅛	119⅛	Mc. 29, Q	1.75
Virginia I. C. & C.	New York	....	....	49	De.15, Ja. 2	1.50
Virginia I.C.&C.pfd.	New York	78	78	78	De.15, Ja.22	2.50
VANADIUM						
Vanadium Corp.	New York	30⅛	25⅛	25⅛	Jan. '21, Q	1.00
ASBESTOS						
Asbestos Corp.	Montreal	35	35	35	Se.29, Oc.15 Q	1.00
Asbestos Corp. pfd.	Montreal	60⅛	59	59	Ap.1, Ap.15, Q	1.50
SULPHUR						
Freeport Texas	New York	11	10	10⅜	Nov '19, Q	1.00
Texas Gulf	New York	61⅛	59⅛	59⅛	Mh.3,Mh.15QX	1.75
PLATINUM						
So. Am. Gold & P.	N. Y. Curb	4	3⅛	3⅛	....	....
MINING, SMELTING AND REFINING						
Amer. Metal	New York	45⅜	43¼	45	Fe.18, Mh.1, Q	0.75
Amer. Metal pfd.	New York	....	....	112	Fe.20,Mh.1, Q	1.75
Amer. Sm. & Ref.	New York	62¼	59¼	60⅛	Ja. 11, Fe. 1, Q	1.25
Amer.Sm.&Ref.pfd.	New York	99	97	98	Fe.20, Mh.1,	1.75
U. S. Sm. R. & M.	New York	21⅛	20⅛	20⅛	Jan. '21, Q	0.50
U.S. Sm. R.&M.pfd.	New York	39⅝	37⅛	37⅛	Ja.7, Ja.15 Q	0.87½

* Cents per share. † Bid or asked. Q, Quarterly. SA, Semi-annually. M Monthly. K, Irregular. I, Initial, X, Includes extra.

Toronto quotations courtesy Arthur E. Moysey; Spokane, Pohlman Investment Co.; Salt Lake, Stock and Mining Exchange; Los Angeles, Chamber of Mines and Oil; Colorado Springs, Colorado Springs Stock Exchange.